AN INTERACTIVE LEARNING PROGRAMME FOR PRIMARY MATHEMATICS

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DECLARATION

It is hereby certified that, except where the work of others has been specifically quoted, this thesis is entirely the result of the candidate's own investigation.

It is also certified that this thesis has not alreay been accepted in substance for any degree, and is not being concurrently submitted in candidature for any degree

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Abstract

This research seeks to identify a set of principles that underpin a discussion-based approach to the teaching of primary mathematics.

In order to build up a picture of the ways in which children learn, a series of effective mathematical activities have been developed and used with a sample group of children. The children were chosen from the first National Curriculum cohort (Year 1) at Porth Infants School, and were monitored over a period of two years. The data and information collected refers to the children's mathematical development between 1989 and 1991.

The activities provide access to a wide range of differentiated learning experiences and encourage children to develop a variety of skills including those associated with speaking and listening, using and applying mathematics, and social awareness.

In order to provide accurate, valid and reliable information concerning pupils' progress, a series of assessment sheets have been developed to support the activities. The sheets provide a manageable means of recording progress and provide evidence of attainment and achievement. They are particularly useful for monitoring individual progress within a group activity.

Guidelines have been developed to aid classroom management and various strategies have been identified to improve the quality of teaching and learning. In addition, the importance of discussion as a tool for teacher assessment and planning is considered. Support materials and guidelines for teachers wishing to provide an effective approach to assessment, recording and reporting have been developed. These guidelines, together with the activities and the recording sheets, form a package which can be used to help teachers implement the National Curriculum for Mathematics through an interactive discussed-based teaching approach.

CHAPTER 1

MATHEMATICS AND THE PRIMARY CURRICULUM - AN HISTORICAL PERSPECTIVE

1.1 MESSAGES FROM THE PAST

Mathew Arnold's General Report[1] for 1889 criticised teaching methods of the day for placing too great an emphasis on mechanical processes and rote learning. The Report also provided a warning of the dangers of an examination system which controls the curriculum with a "payment by results" policy:

> "I have repeatedly said that it seems to me the great fault of the **Revised Code**, and of the famous plan of 'payment by results is that it fosters teaching by rote; I am of that opinion still ... . The School Examinations in view of 'payment by results' are as I have said a mechanical contrivance in which the teachers will and must more and more learn how to beat us. It is found possible, by ingenious preparation, to get children through the Revised Code examination in reading, writing and ciphering without their really learning how to read, write and cipher ..."
>
> (page 31, para. 2)

The Elementary Code[2] (1904) identified the aim of the school as that of training children in skills of observation and reasoning. The Report emphasized the power of language as an instrument for thought and expression.

> "It will be the aim of the School to train the children carefully in habits of observation and clear reasoning, so that they may gain an intelligent acquaintance with some of the facts and laws of nature; to arouse in them a living interest in the ideals and achievements of mankind, and to bring

> them to some familiarity with the literature and history of their own country; to give them some power over language as an instrument of thought and expression, and, while making them conscious of the limitations of their knowledge, to develop in them such a taste for good reading and thoughtful study as will enable them to increase that knowledge in after years by their own efforts".
>
> (page 154, para. 3)

The Report also highlighted the role of the teacher in encouraging the child's natural activities and providing opportunities for "suitable forms of practical work".

The Handbook of Suggestions for Teachers[3] (1918) emphasized the importance of teachers deciding upon their own methods of working which should be matched to the needs of their school. In so doing teachers needed to recognise the responsibilities that such freedom carried:

> "The only uniformity of practice that the Board of Education desire to see in the teaching of Public Elementary Schools is that each teacher shall think for himself, and work out for himself such methods of teaching as may use his powers to the best advantage and be best suited to the particular needs and conditions of the school. Uniformity in details of practice (except in the mere routine of school management) is not desirable even if it were attainable. But freedom implies a corresponding responsibility in its use."
>
> (prefatory Note)

The Report commented on the attitude of teachers to their work and the special relationship that is built up between the teacher and the child:

> "The Teacher and his Work - The essential condition of good education is to be found in the right attitude of the teacher to his work .... The teacher must know the children and must sympathize with them, for it is of the essence of

> teaching that the mind of the teacher should touch the mind of the pupil. He will seek at each stage to adjust his mind to theirs, to draw upon their experience as a supplement to his own, and so take them as it were into partnership for the acquisition of knowledge. Every fact on which he concentrates the attention of the children should be exhibited not in isolation but in relation to the past experience of the child; each lesson must be a renewal and an increase of that connected store of experience which becomes knowledge."
>
> (page 9)

By the 1930s support for a coherent policy on primary education was well established. The Report of the Consultative Committee on Primary Education[4] (1931) chaired by Sir W. H. Hadow, commented that:

> "It is true indeed that the process of education from the age of five to the end of the secondary stage should be envisaged as a coherent whole - that there should be no sharp division between the infant, junior and post primary stages and that transition from any one stage to the succeeding stage should be smooth and as gradual as possible".
>
> (page 6, para. 3)

The Report identified the general aims of the primary school as

> "arousing in the pupil a keen interest in things of mind and in general culture, fix certain habits and develop a reasonable degree of self confidence, together with a social team spirit".
>
> (page 7, para. 1)

The Committee gave their opinion of how the curriculum of the primary school should be viewed by placing emphasis on "activity and experience". These issues were again raised in the "Report of the Consultative Committee on Infant and Nursery Schools"[5] (Hadow Report, 1933):

> "...the curriculum of the primary school is to be thought of in terms of activity and experience rather

than of knowledge to be acquired and facts to be stored".

(page 183, para. 44)

This Report supported the point of view that any curriculum planning must make use of certain elements of experience because they are part of the common life of mankind:

"In the provision of opportunities for further experience and experiment, the infant school must make a delicate compromise between the immediate powers and needs of the child and his future requirements as a potential adult".

(Recommendation 45, page 183)

Throughout the Report there is emphasis on the 'physical' and 'social' growth of the child, with guidance on how to develop a caring and healthy environment:

"its aim is not so much to implant the knowledge and the habits which civilised adults consider useful, as to aid and supplement the natural growth of the normal child".

(page 118, para. 3)

However, the Report also recommends the need for training as well as care:

"During the nursery stage the child is gaining knowledge of the world about him through his senses and reflecting the use of his senses as a means of exploring his environment, the school should surround him with objects and materials which will attract his attention and provide him with scope for experiment and exploration".

(page 119, para. 3)

The 1933 Hadow Report is invaluable as a history of the infant school. It describes more than 100 years of steady growth and progressive practice so

that when primary education was at last established as a separate phase it had a sound tradition upon which to draw. At infant level the nature and needs of children had become central to thinking and were accepted as the basis of good educational practice.

In June 1944 an Education Bill[6] was put before Parliament and, for the first time in our history, primary education was established as a separate stage in a national scheme for education:

> "The statutory system of education shall be organised in three progressive stages to be known as Primary Education, Secondary Education and Further Education, and it shall be the duty of the Local Education Authority (LEA) for every area so far as their powers extend, to contribute towards the spiritual, moral, mental and physical development of the community by securing that efficient education throughout the three stages shall be available to meet the needs of the population of their areas".
>
> (page 3, para. 2)

1.2 THE POST WAR PERIOD

Following the recognition of primary education as the first stage in a continuous cycle of educational opportunity, there appeared to be a widespread and quickening interest in primary work amongst both teachers and the general public. As teachers developed a better understanding of the ways in which children learn and apply knowledge, so they were able to identify much more clearly children's achievements in a whole range of areas and directions. Consequently, one of the salient features of primary education in the early 1950's was the deepening concern with children as children which gradually spread itself from nursery and infant schools into junior schools.

In 1959 a report entitled 'Primary Education (Suggestions for the consideration of teachers and others concerned with the work of Primary Schools)'[7] was published. This book was produced as the result of an identified need for a more "critical consideration" by teachers of the quality and substance of what they offered children for learning. The authors recognised the need for pupils to be treated as individuals and required teachers to work to a

> "firmer realisation that children's capacities, whether they be small or great, should be exercised to the full"
>
> (page v, para. 3).

In some ways this book can be thought of as an extension of a series to which earlier 'Handbooks of Suggestions for the Consideration of Teachers' belonged. From 1905 onwards the Board of Education had published such a series with each book revised or re-written in the light of comments on its predecessor and HMI experience in schools. Each version reflected changes in outlook and emphasis of the day and all were published prior to the 1944 Education Act.

Like its predecessors, 'Primary Education' sought to strengthen and not to diminish the individual teacher's sense of responsibility. But, unlike earlier books, it was concerned exclusively with the primary phase, the stages of development of the child and his/her needs:

> "From a very early age a child experiments with personal relationships. He tries out various kinds of behaviour to see what happens .... it is not until they are about four or five years of age that children play much together, though many like being in each other's company, show a deep interest in each other's appearance and activity and may even choose one or two of their companions as personal

> friends. Some children are not yet capable of anything but casual and short lived cooperation; yet they need the experience of being with their peers and are emotionally handicapped if they are deprived of it".
>
> (page 17, para. 4)

The Report emphasised the importance of the role of the teacher in getting children to work together and share equipment

> "...if an understanding adult intervenes gently and shows them how to take turns, they quickly learn, and they learn too to accept less of something in order that others may have a share. This sort of experience is one of the roots of our later ideas of justice".
>
> (page 17, para. 5)

The Report also highlighted the importance of language development as part of intellectual growth

> "A child with whom no-one talks, or to whom no-one listens, or with whom no-one shares the delights of speech is deprived indeed".....
>
> (page 19, para. 1)

Language is not only something learnt - it is a way of learning.

In discussing the place of mathematics learning in a child's development the report recognised the practical and utilitarian nature of the subject

> "If the learning of mathematics is conceived of as nothing more than the daily grinding out of pages of mechanical sums, then probably there is little justification for spending a great deal of time on it. If, however, it is conceived of as something which will help children (and adults) to solve some of the problems of living, to order and extend their everyday experiences so that they may better deal with their affairs, then it becomes of great importance. The attempt to achieve this aim makes

> more demands on the teacher, but there will be compensation in the added interest and stimulation which both teacher and children will enjoy".
>
> (page 180, para. 2)

In considering the teaching of mathematics, the report looked in depth at ways in which children learn, and the processes that allow them to understand. Again the authors highlighted the responsibility of the teacher:

> "Responsibility for being aware of what depth of understanding can be demanded from particular children rests with the teacher as he alone watches the learning process from day to day. Very little is known of the mental processes by which children learn mathematics, but research which has been done suggests that children are too often expected to deal with mathematical ideas which they do not sufficiently understand and cannot assimilate in their early school days".
>
> (page 184, para. 1)

and reiterated the fact that mere accuracy of computation is not enough:

> "Certainly children must learn addition and multiplication facts and they must learn addition, subtraction, multiplication and division processes as applied to numbers and quantities ... Nevertheless, he must also know ***what*** work he wishes to do with his 'tools' and what 'tools' are required for a given purpose".
>
> (page 185, para. 1)

Throughout the report there is reference to the role of the child in the learning process. In mathematics particularly the notion of the child as an active participant, is central to the development of understanding.

> "If children are to play an important part in their own learning of mathematics then there will be interplay between the minds of the teacher and of the children themselves. This will entail discussion; therefore it is important that there should be talking in mathematics lessons, the

> discussion of new situations for which the children's present knowledge is inadequate, the development of that knowledge further, perhaps to the stage of evolving a new process and the seeing of the implications of the new discovery".
>
> (page 185, para. 3)

The authors concluded the section on mathematics education by expressing concern about the poor attitudes of pupils leaving schools, and the part that rote learning plays in such a deplorable state of affairs.

> "It is well known that many young people are leaving our schools at the age of 15 or older with a positive distaste for mathematics; teachers in primary schools can do much to prevent the development of this attitude, which so often arises because children have learned their mathematics by rote and have seldom seen enough meaning in what they are being required to do".
>
> (page 211, para. 3)

No review of primary education would be complete without reference to the recommendations of the revolutionary Report by the Central Advisory Council for Education "Children and their Primary Schools"[8], commonly known as The Plowden Report. This report was commissioned in 1963 by the then Minister of Education, Sir Edward Boyle, who requested that the Central Advisory Council should: "consider primary education in all its aspects, and the transition to secondary education". In undertaking such a task the Council was in effect being invited to examine to what extent the recommendations of Sir Henry Hadow and his Committees had been implemented.

Throughout the Plowden Report there is much discussion concerning the general nature of primary education with the Council comparing the contemporary provision with the arrangements in force when the Hadow Report was published (1933). An in-depth evaluation of the ***quality*** of

education provided during the 1960's is undertaken and descriptions of primary schools which exhibited good practices are given. At this time schools were classified by HMI into categories 1 to 9, as exemplified by the following descriptions.

> (1) "In most respects a school of outstanding quality. These are schools which are outstanding in their work, personal relationships and awareness of current thinking on children's educational needs. They are pacemakers and leaders of educational advance".
>
> (2) "A good school with some outstanding features. These were schools of high quality far above the average, but lacking the special touch of overall rare distinction needed to qualify for the first category".
>
> (9) "A bad school where children suffer from laziness, indifference, gross incompetence or unkindness on the part of the staff".
>
> (page 101, para. 4)

The Plowden Report is encouraging in relation to curriculum development generally and mathematics education specifically:

> "'Finding out' has proved to be better for children than 'being told'. Children's capacity to create in words pictorially and through many other forms of expression is astonishing. The third of the 3 R's is no longer mere mechanical arithmetic. French has made its way into the primary school, nature study is becoming science. There has been dramatic and continuing advance in standards of reading..... our report is a report of progress and a spur to some".
>
> (page 460, para. 1233)

The obvious broadening of the mathematics curriculum is also reflected in 'The Schools' Council Bulletin 1 - Mathematics in the Primary School'[9].

The Plowden Committee acknowledges the importance of this document, emphasising its usefulness for teachers:

> "It contains many fascinating accounts of children's work and activities, and can be recommended to any reader who wishes to know in detail what modern teaching of mathematics in the primary school is like".
>
> (page 236, para. 2)

The increasing recognition of the importance of activity and 'discovery methods' in mathematics is further evidenced by the Nuffield Project[10], first published in 1979, sponsored by the Schools Council and developed under the 'banner'

> "I hear and I forget
> I see and I remember
> I do and I understand"

One of the tangible outcomes of the Nuffield Project was the publication of a series of mathematics handbooks for the use of primary teachers. At every stage during the production of these books care was taken to fully involve primary teachers. This initiative did much to create a professional awareness of the major issues involved in mathematics teaching and learning. The Project later became known as the 'do-it-yourself' scheme and has acted as a model for many of the curriculum development initiatives which have followed.

1.3 THE 1970's AND EARLY 1980's

In 1970 the Plowden Report was already over three years old. This report, which put forward the case for 'child centred education', had influenced many primary schools and offered support to the Nuffield Project and the Schools Curriculum Council. A consequence of this report and one of the major innovations in some schools during the 1970's was a move towards individualised learning in mathematics. By allowing children to work at their own pace it was felt that they would come to understand mathematics for themselves. Unfortunately, as schools attempted to adapt to the Plowden emphasis on "all round development of the individual" many failed to apply to mathematics the injunction that:

> "Communication by the spoken word is at least as important as writing and for the majority perhaps more important".
>
> (page 186, para. 498)

It is interesting to note that the Bullock Report 'A Language for Life'[11], which carried the same underlying philosophy, did not appear until the mid seventies. Bullock provided an 'authoritative statement' for everyone concerned with education. Many of the recommendations were addressed to schools and teachers, and called for a change of approach and redirection of effort. This Committee of Inquiry's brief was to develop 'language in education' but in so doing they produced recommendations that were far-reaching and which are particularly relevant to the ways in which children now learn mathematics in our primary schools:

> "Exploratory talk by the pupils has an important function in the process of learning".
>
> (page 526, para. 108)

> "pupils should learn to regard discussion as an opportunity to investigate and illuminate a subject".
>
> (page 526, para. 114)

> "A stimulating classroom environment will not necessarily of itself develop the children's ability to use language as an instrument for learning. The teacher has a vital part to play and his role should be one of planned intervention".
>
> (page 526, para. 112)

The 1970's and early 1980's was a period of intense debate concerning what constituted "good primary practice". HMI were particularly active during this period and a number of surveys were undertaken. One of these, 'Primary Education in England'(1978)[12], gave a rigorous and professional appraisal of the developments in primary education since the 1933 Hadow Report. As the first of its kind, this report provided an opportunity for professional discussion based on a working knowledge of policy and practice. Study of the evidence revealed in this survey showed that the anticipated move towards a 'child centred approach' recommended by the Plowden Report had not materialised on a noticeable scale. Except for a small number of schools most primary teachers had not responded in the way the curriculum developers naively assumed they would:

> "in far too many schools teachers paid too much emphasis on repetitive mechanical processes with children who had already (in many cases) mastered the skills necessary".
>
> (page 54)

This view was supported by a later survey 'Education 5-9' (1982)[13], which made it clear that HMI were critical of mathematics teaching in the same way that they were critical of teaching in other areas of the primary curriculum:

> "Teachers devote much time to work with numbers and in practice of the four rules ... many children achieve a satisfactory level of competence in this narrow field, but *few* have sufficient opportunity for learning how to apply the skills they acquire to the solving of problems ... Too few schools make good use of the opportunities for the development and extension of mathematical understanding which arise in children's play, in their interests, and in work in other parts of the curriculum".
>
> (para. 4.9)

The HMI document 'Mathematics 5 to 11 - A Handbook of Suggestions'[14] took several years to draft, and when it appeared in 1979 it advocated a broad curriculum in primary mathematics.

> "The Primary teacher today is faced with a considerable task, brought about by changes which have taken place in the teaching of mathematics. ... Today the child is encouraged to make enquiries, investigate, discover and record; learning is not something looked upon only as something imposed from without. It is recognised that it is through his own activity that the child is able to form the new concepts which in turn will be the basis of further mathematical ideas and thinkings. These early experiences provide the foundation on which future learning is built".
>
> (page 7, para. 2)

The document gave sound and helpful advice on many matters including aims, planning, content, practical and investigatory work:

> "There is a certain amount of misunderstanding about investigation in mathematics; it is sometimes thought to be synonymous with practical work. In fact, while young pupils' investigations usually involve actual material and practical experimentation, it should be remembered that for much of the investigation by older children in the primary school only paper and pen are required. The practical and the abstract are inter-dependent at every stage, but with increasing maturity the theoretical component should increase for most children".
>
> (page 1, para. 4)

During the 1970s the 'Great Debate' on the quality of education in England and Wales was raging. At this time the Expenditure Committee of the House of Commons decided that:

> "it would be appropriate to examine the validity and substance of criticisms from many quarters, and especially from employers, about the apparent deficiency in basic skills among school leavers applying for jobs".

The House of Commons Committee recommended that the Secretaries of State for Education and Science (The Rt. Hon. Sir Keith Joseph) and the Secretary of State for Wales (The Rt. Hon. Nicholas Edwards) should set up an enquiry into the teaching of mathematics. The resulting committee, under the chairmanship of Sir William Cockcroft (1978), was provided with a brief to look widely at mathematics teaching in both primary and secondary schools. During their three years of study, the committee was able to carry out a thorough investigation of mathematics teaching and learning in England and Wales. When their Report[15] was published in 1982, the committee was able to offer a comprehensive and authoritative over-view of the state of mathematics education in schools in England and Wales.

In the first part of their report the Cockcroft Committee sought to identify the mathematical needs of children in adult life. This was followed by a discussion of the ways in which a balanced and coherent mathematics curriculum could provide for these needs. The final part of the Report dealt with the provision and support which is necessary to enable good mathematics teaching and effective mathematics learning to take place. In these respects Cockcroft whole-heartedly supported the use of practical methods in the primary classroom:

> "Practical work is fundamental to the development of mathematics at the primary stage".
>
> (page 72, para. 247)

The need for the children to understand the mathematics they do, and to think for themselves, is considered paramount:

> "We do not believe that it should be necessary in the teaching of mathematics to commit things to memory without at the same time seeking to develop a proper understanding of the mathematics to which they relate".
>
> (page 70, para. 238)

The Report emphasised that this approach was not new to schools and had been advocated for many years. The report referred to the 1960s work of the Nuffield Maths Project, and gave new impetus to the use of teaching styles which were based on child-centred experiences. Within this framework a style of teaching which is founded on language and discussion is advocated. The Cockcroft Committee stated that it did not intend putting forward a particular style of teaching for mathematics since:

> "... we do not believe that this is either desirable or possible. Approaches to the teaching of a particular piece of mathematics need to be related to the topic itself and to the abilities and experience of both teachers and pupils".
>
> (page 71, para. 242)

However, the Committee seems to have had a clear idea of the general style of teaching which they believed should be used in primary mathematics. The emphasis throughout the Report is on a teaching-style in which language plays a central role in producing an 'understanding of mathematics' that is attained through practical work, problem-solving and enquiry-based methods.

> "... for most children practical work provides the most effective means by which understanding of mathematics can develop. It enables them to think out the mathematical ideas which are contained in the various activities they undertake at the same time as they are carrying out these activities".
>
> (page 84, para. 289)

The Cockcroft Committee regarded problem solving and investigatory work as essential components in mathematics learning:

> "The ability to solve problems is at the heart of mathematics. Mathematics is only useful to the extent to which it can be applied to a particular situation and it is the ability to apply mathematics to a variety of situations to which we give the name 'problem solving'. The idea of investigation is fundamental, both to the study of mathematics itself and also to an understanding of the ways in which mathematics can be used to extend knowledge and to solve problems in very many fields".
>
> (page 73, para. 249-50)

A similar importance is attached to the role of language in learning mathematics and of the importance of enabling teachers and children to see that mathematics is a powerful means of developing communication skills:

> "The ability to 'say what you mean and mean what you say' should be one of the outcomes of good mathematics teaching. This ability develops as a result of opportunities to talk about mathematics to explain and discuss results which have been obtained, and to test hypotheses ...."
>
> (page 72, para. 246)

In order to support the development of all aspects of mathematics learning, the Cockcroft Committee recommends schools to seek a 'balance' between six styles of teaching:

"• exposition by the teacher;
• discussion between teacher and pupil and pupils themselves;
• appropriate practical work;
• consolidation and practice of fundamental skills and routines;
• problem solving, including the application of mathematics to everyday situations;
• investigational work."

(page 71, para. 243)

This list draws together individual recommendations that had often been made previously in DES publications, HMI discussion papers and journals of the professional mathematical associations, and is perhaps one of the most quoted references in all of mathematics education. It recognises the need to treat the learner as a mathematical thinker who develops understanding through a process of activity, discussion and exploration. As such it is fundamental to the development of this research project and the notion of interactive learning.

CHAPTER 2

CHILDREN LEARNING MATHEMATICS

2.1 SOME THEORETICAL ISSUES

Many of the changes in mathematics teaching during the last fifty years have been prompted by ideas associated with "cognitive development" which perceives human beings as information processors, thinkers and creators. Much of the work in this area can be attributed to Jean Piaget and Jerome Bruner.

Professor Jean Piaget (1896-1980) was one of the first researchers to make a substantial contribution in this area through his lifetime's work in Geneva. His methods centred around the investigation of many aspects of the development of young children, using "verbal responses" which were made to structured questions. However, this "clinical" method lacked a statistical basis and was not accepted by many other psychologists.

In the last thirty years, Piaget's work on the child's understanding of number, space, volume, weight and time has had a major influence on mathematics education. His research indicated that concepts are constructed largely from a series of experiences, and he claims that two forms of construction are possible:

i) **assimilation** which is the absorption of new experiences; and

ii) **accommodation** which is the modification of an existing concept.

When a young child is learning mathematics, he/she has to develop concepts associated with number, shape, length and so on. Piaget argued that this intellectual development requires the child to pass through five qualitatively different stages. To support this development the teacher must provide a programme of work that builds on experiences from the earlier stages, and thus facilitates progress into a later stage. Not all children will be able to reach the final stage for all mathematical concepts which they learn, but nevertheless, experiences should be provided to encourage maximum progress. Piaget defines the five stages as:

1. sensory-motor: birth to 2 years, when the child learns to organise his actions;

2. preconceptual thought: 2 to 4 years when the child's concepts lack generality;

3. intuitive thought: 4 to 7 years, when a child can think about actions, but cannot make mental comparisons;

4. concrete operations: 7 to 11 years, when a child can think logically about objects and events of which he has direct concrete experience;

5. formal operations: 12 years onwards, when the person has a capacity for abstract thought, for example the ability to think logically about mathematics relations.

During each of these five stages the learner is forming his/her own representation of reality using "accommodation" and "assimilation". Piaget insisted that the learner must actively participate in the work in order to develop a "construction" of reality rather than merely accepting a "copy" of reality.

In Britain, Piaget's theories were first applied in primary schools and are reflected in the work of the Nuffield Project and the Schools Council (see Section 1.2). Shuard[16] writes:

> "Since the 1960's, the theoretical underpinning of much thinking about Primary Mathematics has been the work of Piaget ... especially attractive to workers in mathematical education were Piaget's conceptions that children's intellectual development progresses through well defined stages, that children develop their concepts through interaction with the environment and that for most of the Primary Years most children are in the stage of "concrete operations".
>
> (page 61, para. 1)

The emphasis on practical activity in the primary classroom thus has the implicit support of Piaget's theory of cognitive development.

Central to Piaget's theory is the theme that any instructional programme must take the characteristics of the learner into account. His theory has been interpreted as advocating a "child-centred" or an "environment-centred" education. He emphasised the need for instructional experiences to be matched to the child's level of cognitive development and that all cognitive growth comes from experience in the environment. Through interaction with the environment the child assimilates and accommodates information which results in a cognitive change.

Although Piaget is still regarded as a great pioneer of developmental psychology, there has been a growing stream of fundamental criticism of Piaget's theory. Work in both psychology and mathematical education has revealed a variety of further ideas that need to be taken into account in thinking about children's mathematical learning. The influence of Piaget's work has been paramount, but he paid little attention to the child's interaction with people. Instead, he focused attention on the need for children to work alone with their own apparatus, discovering mathematical concepts for themselves. In this respect, Piaget saw children below the age of seven as fundamentally egocentric and unable to carry on what could be described as 'conversation' or to learn through discussion.

Professor Jerome Bruner was the Director of the Center for Cognitive Studies at Harvard University. He is renowned for his work on the efficient organisation of learning. Bruner proposes similar sequential stages of intellectual development to Piaget. He refers to these three stages as **enactive, iconic** and **symbolic**, and calls them "Systems of Representing Reality". They are used by adults and children alike when learning mathematics, and as such do not fit into Piaget's age-related stages of cognitive development. Bruner identifies "learning by discovery" as an important characteristic and believes that pupils should not only acquire a body of mathematical knowledge, but also learn to "think like mathematicians".

Zoltan Dienes worked at the University of Sherbrooke, Quebec, for many years, and is an acknowledged leader in designing apparatus which encourages children to develop their mathematical thinking. Much of his theory of learning was based on the work of Piaget and Bruner. Dienes' approach is based

on a method of learning which begins with practical activity in which the pupil accumulates experience before progressing to a formal mathematical summary. To support this teaching sequence, Dienes designed apparatus and carefully planned its use. Pupils start with preliminary or free-play activity with the apparatus before progressing to structured games with rules and clear objectives. Graphical representation and the use of suitable language is in-built and a final stage is the formulation of axioms and mathematical proofs.

Vygotsky[17] has suggested that many concepts cannot be developed from direct experiences alone and that language is a key element in helping children to understand abstract relationships. The interaction between learning and language has been considered by a number of other workers, and the body of research evidence suggests that the learning of language by young children is a social act in which even very young children can develop quite advanced skills in interacting with people. In this respect, Donaldson[18] argues that young children have a strong capacity for "making sense" of situations through interaction:

> "In the early stages, before the child has developed a full awareness of language, language is embedded for him in the flow of events which accompany it. So long as this is the case the child does not interpret words in isolation - he interprets situations. He is more concerned to make sense of what people do when they talk and act than to decide what words mean. ... Indeed, personal relations appear to form the matrix within which his learning takes place".
>
> (page 88, para. 2)

In her third book *Talk for Teaching and Learning*, produced by the School's Council and Communication Skills Project, Tough[19] puts forward a

theoretical view of language and learning. She begins by acknowledging the importance of direct experience:

> "Three main sources underlie the views put forward in this book. The first is concerned with the fundamental basis of children's learning. The work of Piaget and his associates is convincing. Children's learning begins with the information they gain through their senses about aspects of the world around them. They see, examine and manipulate objects and materials. Their own interaction with concrete aspects of living provides them with information that builds up into an internalised mode to which they can refer .... children's first hand experiences form the basis of their learning and understanding".
>
> (page 6, para. 3)

She goes on to emphasise that direct experience forms only part of the child's total experience and for much of the time the child is involved in social exchange with people. In this respect she notes that:

> "The work of Vygotsky helps us to understand the way in which these two aspects of the child's experiences influence one another".
>
> (page 6, para. 4)

According to Vygotsky, as the child hears and uses language so he is being helped to order and classify his experiences. In time words come to represent generalised notions, abstracted from many experiences and so become a means of communicating when the events to which they refer have passed, or have not yet happened. Although many see conflict between Piaget and Vygotsky, Joan Tough takes the view that both positions are tenable and each throws light on the role language plays in children's cognitive development.

Professor Richard Skemp is a mathematician and educational psychologist, and formerly head of the School of Education at the University of Warwick. In his popular "Penguin" book *The Psychology of Learning Mathematics*[20] he identifies processes in children's learning by which they build and test mathematical ideas. This is done, he suggests, partly by reflection (their own thinking) and partly by discussion (either amongst themselves or with the teacher).

Skemp also identifies a number of characteristics of discussion and highlights the benefit these have for children's learning:

> "there is more to discussion than just thinking aloud .... the interrelating of our ideas with those of others, the expansion of our ideas to enable us to assimilate their ideas and the explanation of our own ideas to them to enable them to assimilate our ideas to their schemas".
>
> (page 115, para. 1)

He suggests that children are able to 'build up' ideas by engaging in discussion and activity, and that a similar process allows them to 'try out', or test, their ideas on one another.

Interactions of this type, he argues, allow for cross fertilisation of ideas and for learning to take place. Sharing points of view in this way can initiate new ideas in participants and can result in a creative and exhilarating experience for all concerned. Skemp sums up by commenting favourably on the benefits of discussion but he also warns that success will be dependent on friendly and fairly informal personal relationships between members of the group.

> "... There must be agreed forms of behaviour such as willingness to take turns to speak, to listen, to consider the viewpoint of others. These are important parts of civilised discussion and are not too easily achieved".
>
> (page 116, para. 1)

In his book *Children's Concepts and the Primary Curriculum*, Willig[21] identifies various strategies designed to extend children's thinking. These include:

- encouraging a cognitive conflict;
- structuring meaningful reception learning;
- encouraging observation;
- promoting self monitoring and control of one's own cognitive process.

Willig emphasises the need for these strategies to be based on the principle of "matching the learner's level of ability to the new material". He describes the Piagetian "cognitive conflict principle" as the ability by teachers to ask penetrating questions or to pose practical problems that surprise learners and force them to reflect on what they know.

> "When we come across something we do not understand we are thrown off balance. As this situation is difficult to tolerate we try to restore the balance by solving the problem, and, in the process thinking is raised to a higher standard".
>
> (page 16, para. 2)

Willig also stresses the importance of carefully thought out questions in the role of the cognitive conflict strategy.

> "The questions teachers ask of their classes must have varying effects on the pupils. When faced with a new situation, the most able are likely to grasp the issues quickly and resolve the dilemma at a level well in advance of their original position. The middle group would still progress but not at so fast a rate, while the views of some less able pupils might well remain undisturbed by the questioning. In such class and group discussions children seem to take what they are ready for, no more and no less".
>
> (page 17, para. 4)

He describes "meaningful reception learning" as "teaching by telling" and emphasises it's main role as "that of giving information directly to children". The notion of "telling" as opposed to "discovering" seems to go against progressive methods of education and as a result has been viewed unfavourably by some teachers. However, there are some educational experts who are eager to reinstate such an approach in our schools. In arguing this case, Ausubel[22] makes a careful distinction between "rote" and "meaningful" learning. The former he says is entirely dead knowledge. It stands by itself because it has no connection with information or insights acquired in the past. In contrast, meaningful learning fits in comfortably with existing concepts and is made the learner's own in a way that knowledge acquired by rote can never be. Because no physical activity is involved, "reception learning" has sometimes been equated with "passive" learning. It should be more widely recognised that meaningful reception learning involves considerable mental activity on the part of the child.

Teachers are constantly being encouraged to give children opportunities to observe "first-hand". This view is supported by "Primary Education in England and Wales"[23].

> "There is hardly any aspect of the curriculum in which children can make progress without taking careful note of what they see, hear or otherwise experience and without thinking about their observations."
>
> (page 43, para. 5.10)

Willig recognises the need for observation but adds a condition:

> "if observation is going to be anything other than superficial, it must be backed up with knowledge".
>
> (page 18, para. 5)

Willig also refers to control of one's cognitive process as "learning by thinking about thinking". He reiterates the fact that Piaget tended to minimise the importance of social context on learning and emphasises the fact that this is the reason why the work of Vygotsky and Bruner have done much to raise an awareness of the role of the adult in learning.

> "Bruner for example talks about "scaffolding" - a process in which adults provide a range of props for young learners that are gradually withdrawn as competence increases. Much teaching in schools now follows this pattern with teachers acting not so much as givers of knowledge but as facilitators of learning".
>
> (page 20, para. 5)

The theoretical issues summarised above have provided a framework for the learning activities which have been developed within this research project. Through an analysis of these issues, guidelines have been developed that reflect the good practice discussed in this chapter. The following key points have been identified and are discussed more fully during successive chapters.

- Children learn mathematical concepts through their own activity

- Children's first-hand experiences form the basis of their learning and understanding

- Although children think and reason in different ways, they all pass through stages which are dependent on their experiences as well as their chronological and mental ages

- Learning is accelerated if suitable experiences and appropriate language are introduced simultaneously

- Practice is necessary to consolidate a concept once it has been understood. Therefore practice should **follow** and not **precede** discovery

- The role of language is crucial to the child's cognitive development. As children are learning to use language they are also learning to think

- Children learn by building and testing ideas, through a process of activity, reflection and discussion

- The benefits of discussion are dependent on formal and informal personal relationships between members of a group.

There needs to be agreed forms of behaviour such as willingness to take turns, consideration of others' viewpoints

- Discussion stimulates new viewpoints

- Discussion with fellow pupils is an important contribution to learning. The act of communicating ideas helps clarify them and therefore serves to develop understanding.

2.2 AIMS OF PRIMARY MATHEMATICS EDUCATION

Current educational philosophy and practice demands that schools must cater for the whole child and provide experiences to enhance individual development. The Curriculum Council for Wales (CCW)[24] state that:

> "The school must attribute the utmost importance to the needs of the individual child as a developing member of society. Within these terms the child should be central to the curriculum, its design, its content and its implementation".
>
> (page 3, para. 9ii)

Her Majesty's Inspectorate (HMI)[26] have identified good primary practice as being characterised by pupils:

> "showing a lively interest in the challenges presented to them and by teachers having clear aims and intentions about what the children are to learn".
>
> (page 1, para. 1)

Consequently, teachers need to consider what pupils need to achieve and as a result provide learning situations that support and enable pupils to realise those outcomes.

In their document *A Framework for the Whole Curriculum* the Curriculum Council for Wales[24] endorses the recommendations of HMI in the DES[26] publication *Better Schools* that a school's aims should help pupils to:

> "i) develop lively, enquiring minds, including the ability to question and argue rationally and to apply themselves to tasks; ;
>
> ii) acquire understanding, knowledge and skills relevant to adult life and employment in a fast-changing world;
>
> iii) use language and number effectively;
>
> iv) develop personal moral values, respect for religious values, and tolerance of other races, religions and ways of life;
>
> v) understand the world in which they live and the interdependence of individuals, groups and nations;
>
> vi) appreciate human achievements and aspirations.
>
> (page 4, para. 4)

Aims are essentially declarations of intent, and as such should give direction to a scheme of work or teaching programme which should remain in the forefront of the teacher's mind. When planning mathematics for the pupils formulating aims and then objectives is necessary before attempting to draw up a scheme of work. There are a number of issues to be addressed in order to promote effective planning:

- the need for corporate planning which encourages discussion and sharing of knowledge and expertise amongst all staff;

- the ethos of the school, i.e. the need for the general statement of aims to be reflected throughout specific subjects;

- the need for organisational strategies and physical resources to support the implementation of aims into classroom practice;

- the need for monitoring and evaluation procedures to assess the effectiveness of the curriculum.

HMI in their series "Mathematics 5 to 11 - A Handbook of Suggestions"[14] give a set of general aims for mathematics but point out that the overall aim must be to maintain and increase confidence in mathematics. This confidence will be reflected in pupils by their ability to express ideas fluently, to talk about the subject with assurance, and to use the language of mathematics correctly.

It is noted that general aims should be to develop within pupils:

"(i) positive attitude to mathematics as an interesting and attractive subject;

(ii) an appreciation of the creative aspects of the subject and an awareness of its aesthetic appeal;

(iii) an ability to think clearly and logically in mathematics with confidence, independence of thought, and flexibility of mind;

(iv) understanding of maths through process of enquiry and experiment;

(v) an appreciation of the nature of numbers and space leading to an awareness of the basic structure of maths;

(vi) an appreciation of mathematical pattern and the ability to identify relationships;

(vii) mathematical skills and knowledge accompanied by the quick recall of basic facts;

(viii) an awareness of the uses of mathematics in the world beyond the classroom. Children should learn that mathematics will frequently help them to solve problems they meet in everyday life or understand better many of the things they see, and provide opportunities for them to satisfy their curiosity and to use their creative ability;

(ix) persistence through sustained work in mathematics which requires some perseverance over a period of time".

(page 5, para. 3)

Children's understanding is basic to the development of concepts and skills, and HMI[25] suggest how this understanding can be advanced and in so doing highlight the **needs** of the child in terms of:

"• enlarging their knowledge of the subject or area of study;

• developing those skills through which they can control and direct their own learning, including their linguistic, numerical and manipulative skills;

• building concepts which enable them to generalise, organise and relate ideas to make informed judgements;

• developing attitudes which foster learning including a willingness to question, listen, observe, concentrate on task in hand, work individually and co-operatively and to learn from their successes and their mistakes".

(page 2, para. 3)

The report of the Cockcroft Committee (1982)[15] also drew attention to the need for the primary mathematics curriculum to give pupils opportunity to apply "mathematics to a variety of situations" (page 73, para. 249). The Report pointed out that mathematics should provide primary pupils with a means of 'exploring their environment' and in so doing make use of processes such as classifying, estimating, recording in tabular or graphical form, making hypotheses and generalisations. However, the overriding aim identified by this Report stressed the importance of 'attitudes' and the usefulness of mathematics as a powerful means of communication:

> "The overall aim must be to develop in children an attitude to mathematics and an awareness of its power to communicate and explain which will result in mathematics being used wherever it can illuminate or make more precise an argument or enable the results of an investigation to be presented in a way which will assist clarity and understanding".
>
> (page 96, para. 32)

By analysing the findings of HMI reports and highlighting those elements of 'good practice' common to schools which were considered high performers, it is possible to develop a means of translating general aims into classroom observables. Having decided on a list of general aims it is necessary to look for ways of achieving them. Classroom practices need to be in accord with these aims. It is therefore essential that aims should be developed into more detailed descriptors of performance which teachers can use and accept as criteria for teaching, learning, and assessment. These descriptors can be regarded as objectives which can usually be set out precisely and clearly in terms of what the children are intended to learn. For example, consider the general aim of enabling

children to become numerate. This can be broken down into a series of objectives which require that the pupil should:

- be able to use appropriate vocabulary effectively, e.g., sort, match, count ...
- understand conservation of number
- carry out addition and subtraction processes and apply these in everyday life.

These objectives can be further sub-divided to form **enabling targets** to reach each objective. For example, "to use appropriate vocabulary" requires that the child is able to sort for colour (red, yellow, blue), size (big, small, etc.), texture (rough, smooth, etc.), and use language to explain their own method of sorting. Conservation of number would build on experiences from the pre-number stage, and enabling targets would include:

- ability to match number symbol to set;

- ability to understand the idea of the empty set and that each set has a number property and it is the number of members in the empty set which is called 'zero';

- ability to count 7 coloured bricks and re-arrange them spatially according to their colour. This activity should be repeated for different combinations of colours and the child should be able to determine whether or not there are the same number of bricks in the various subsets;

- ability to count, re-arrange, match and handle 3-D objects in order to develop the idea of conservation of number.

In order to be able to carry out addition and subtraction processes and be able to apply these in everyday situations, children need to acquire skills and knowledge over a period of time. Typical enabling targets include:

- acquisition of number bonds
- understanding the "story of", e.g. 8 = 8+0, 7+1, 6+2 ...
  and 8 = 8-0, 8-1, 8-2, ...
  8 = 8-0, 9-1, 10-2 ...
- ability to understand pattern in number through use of number line
- ability to use number line to count on and backwards
- ability to use number line and other apparatus to carry out addition and subtraction processes.

This process of breaking aims down into criteria-referred objectives and then identifying enabling targets is an extremely valuable planning activity. It is the basis for the development and review of a school's curriculum statement and provides a framework for determining appropriate programmes of study. Further discussion of these matters is taken up in Section 3.5.

No list of aims would be complete without considering the intended audience. The pupils' needs are paramount, but high on any priority list must also be parents and members of the governing body. Much consideration has been given by teachers in Mid Glamorgan to the role parents can play. The Mid

Glamorgan 'Get Together Project'[27] identified the following as major aims to be addressed by schools:

> Teachers need to be able to:
>
> i) make reliable judgements as to what to report upon;
>
> ii) communicate with parents in a meaningful way;
>
> iii) develop above all the sensitivity and empathy to relate to the parent(s) of each individual child.
>
> (page 2, para. 8)

The primary school teacher is also faced with the task of encouraging children to enquire, investigate, discover and record. Children should not perceive learning as something imposed from above but as a pleasurable activity. It is now recognised that it is through the child's own activity that he/she is able to form new concepts which in turn will be the basis for further mathematical ideas and thinking.

Faced with the challenge of implementing the schools' aims into classroom practice and the wealth of apparatus, material and equipment to choose from, the teacher must be capable of making informed choices bearing in mind the needs of the school, the individual class, and the child.

2.3 STYLES OF TEACHING - Discussion-based Approach

When considering what children are expected to achieve it soon becomes apparent that there is a need for a wide variety of methodologies and styles of teaching. Learning becomes a venture in which teaching styles are used to:

- give time and support to the children as a group, individual or class;
- allow teachers to give guidance when the children have problems;
- allow the teacher to identify the needs of each child and to ensure task match.

The Curriculum Council of Wales[24] quotes the Senior Inspector of Schools as stating:

> "The most important aspect of any curriculum is the interaction between teacher and pupil ... teachers teach best and pupils learn best in vivid interaction, where the pupil is engaged on, and an active participant in, well matched tasks, and where the teacher can, through sensitive interaction, enhance pupils' learning and perceive the strengths and weaknesses of the teaching".
>
> (page 11, para. 27)

These comments clearly imply the need for a particular style of teaching which offers opportunities for teacher/pupil interaction, pupil

participation and sensitive teacher intervention. In considering classroom practice, the Cockcroft Report hesitated to recommend a particular style of teaching. Nevertheless, the above requirements were certainly in evidence and particular attention was focused on the need for discussion in mathematics. However, Cockcroft offered little in the way of detailed guidance to help and support teachers coming to terms with the considerable teaching demands that these requirements make.

In response to these challenges, Brissenden[28] has identified a need for teachers to change their role when working with children. He likens the classroom situation to a play with a familiar plot in which the participants fall into accustomed roles. The plot, a typical mathematics lesson, contains little or no scope for discussion, and very little room for pupil 'talk' of any kind. This results in a clear pattern of interaction in which the teacher demonstrates an algorithm or states a 'rule' and then asks questions to determine whether or not the children are able to repeat the process (see Figure 2.3.2). This Brissenden calls the 'three term sequence' and describes the interaction as a 'Guess what I'm thinking' routine. The teacher is very much in control with pupils speaking and listening to the teacher but not to one another. Although the teacher is able to gain information about the extent to which the pupils can repeat the procedure, little is learnt about the pupils' understanding of mathematics. Brissenden emphasises that this is not discussion and characterises what he sees as discussion in an interesting, cohesive manner with examples of ways in which children develop mathematical understanding through talk. These broad characteristics of mathematical discussion include the requirement that:

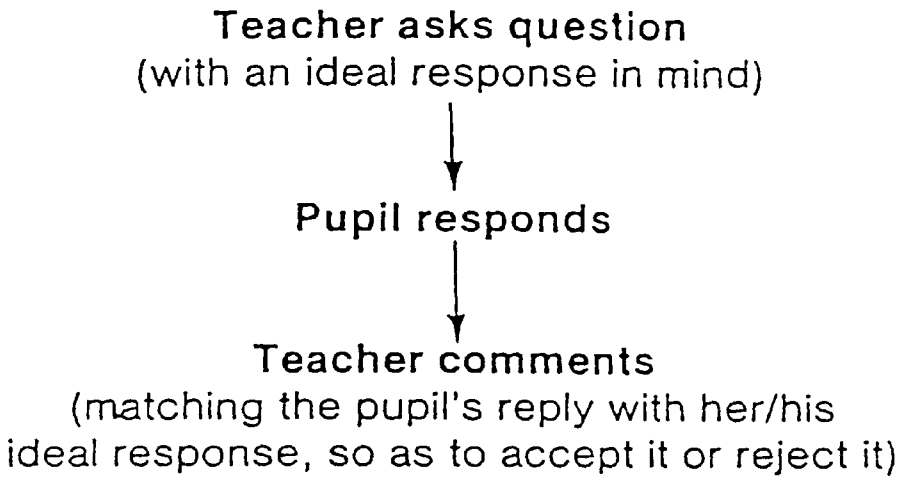


Figure 2.3.1 : The three-term sequence

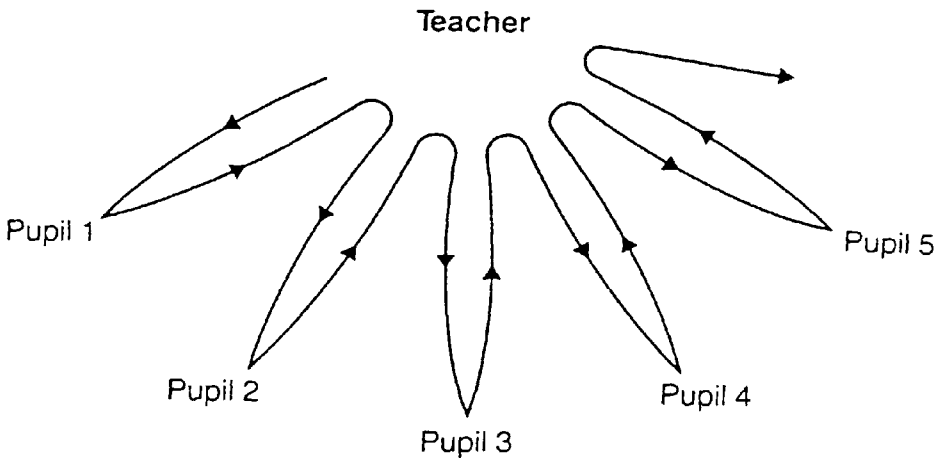


Figure 2.3.2 : An IRF exchange

"1. People speak and listen to one another on an equal footing ....

2. Participants listen to what is actually said - not with some preconceived set of ideal responses in mind ...

3. The various forms of mathematical activity are open to everyone taking part ...

4. Mathematical discussion between a group of children is based on an effective mathematical situation. It will always involve the features of doing - talking - recording ..."

(page 23, para. 5)

The two approaches are summarised in Figure 2.3.3.

The PrIME Project (1985-89) was a major curriculum development initiative established by the School Curriculum Development Committee. The most important aim of PrIME was to help teachers to carry out the recommendations of the Cockcroft Report taking full account of the impact of the new technology. Some ideas from Cockcroft on which PrIME[29] worked included:

- the importance of language in learning mathematics and thinking mathematically;
- the role of investigations and problem solving and of practical work;
- the need for a balance of teaching styles and types of classroom approaches;

1. "Guess what I'm thinking"

Here children

- speak to the teacher, not to one another
- listen to the teacher but not necessarily to one another
- attempt to match their responses to the expected ideal response only known to the teacher
- develop negative attitudes to mathematics and are often afraid to comment in case they give a wrong answer.

2. "Discussion Approach"

Here children

- develop communication skills; they speak and listen on equal footing, they articulate their ideas and comment on those of others (including the teacher's)
- make decisions about which method to adopt and become actively involved in the planning of their own learning situations
- do more of the thinking and decision-making themselves
- reflect on what they have done and as a result build and test their ideas
- develop social skills through cooperation and the sharing of ideas. They learn to be supportive, able to criticise or praise without belittling
- develop positive attitudes

Figure 2.3.3 : Comparison between traditional and discussion-based approach

- the need to see mathematics within the whole curriculum rather than as an isolated subject area;

- the fact that children are mathematical thinkers full of their own ideas.

In addition, the PrIME teams worked on ways of helping teachers:

(i) make full use of the new technology of calculators and computers in primary mathematics;

(ii) explore digital values in teaching about time;

(iii) make use of other technological innovations as they reached the classroom.

This agenda, although daunting in length, was made possible by the fact that the project's work involved many groups of teachers in different parts of the country. Each group worked on one item among those listed. The outcomes of the project nationally were an INSET Pack[29] and a 'Teacher's Guide' on the Calculator Aware Number Curriculum[30].

In Mid Glamorgan, the initiative produced a series of booklets which dealt with the implications of that part of Cockcroft 243 which demanded that mathematics teaching at all levels should include opportunities for "discussion between teacher and pupils and between pupils themselves". The booklets formed an In-Service pack[31] which provided a framework within which teachers could

experience and develop skills in 'discussion based' mathematics teaching. The Mid Glamorgan group met regularly over a period of 3 years and members carried out classroom research to provide the practical basis for the group's theoretical ideas. The LEA Coordinator, Ball, along with the group's research associate, Brissenden[32], also produced a booklet which provided a comprehensive summary of the mechanics of discussion-based teaching.

Ball, working with the Lakatos Primary Group[33] has produced an in-depth study of the ways in which children's learning can be enhanced by sensitively guided discussion in which children articulate their responses to problems and challenges. The authors describe how the teacher can develop strategies to introduce and develop a discussion-based approach in the classroom and provide a summary of key ideas which teachers might use as guidelines. These include advice to:

"• use open ended activities and ask challenging questions;
- provide a focal point for discussion;
- encourage children to share and compare ideas
- keep the children involved;
- ask questions to assess understanding;
- ask helpful questions to aid progress;
- use conventional teaching when required".

(pages 47 to 51)

The activities developed during the present research study take full account of the matters discussed above. They have been designed to enable teachers to gain experience and confidence in using a discussion-based approach,

and are intended as an aid to the professional development of primary practitioners.

CHAPTER 3

CURRICULUM DEVELOPMENT IN ACTION

3.1 THE SCHOOL'S CURRICULUM STATEMENT

The 'School Curriculum Statement' should have clear aims and objectives for every area of the curriculum providing members of staff with guidelines for translating these aims into classroom practice. While the headteacher will occupy a key role in facilitating the critical path through the various phases of development, all staff need to feel a sense of ownership and commitment to the process and its anticipated end products. The statement should be written after consultation and discussion at staff meetings, in which specialist teachers offer informed advice on their particular aspect of the curriculum.

The curriculum statement will form the basis from which the philosophy of the school will develop and grow. As such, it is a crucial document for the management of the school as it will promote effective learning and teaching. The task of curriculum planning and management should be a continuous process and its success will rely heavily on the way in which skills and concepts are acquired. The context for learning needs to be developed in an environment which provides opportunities for children to become active, independent participants in the process. HMI, 'Aspects of Primary Education'[34] recommend a variety of learning experiences and highlight in particular the need for exploratory work and group co-operation:

> "Throughout the primary age exploratory work was central to good mathematics teaching ... discussion, communication and sharing ideas were encouraged and went hand in hand with good mathematical work."
>
> (page 23, para. 69)

Within the classroom children should be encouraged to make decisions and take responsibility for their actions. Consequently, teachers should develop strategies that promote independence and encourage children to think about their work before they rush to adults for help. Promoting independence is an issue for all staff to consider in order that a consistent approach can develop. The school curriculum statement should emphasise the importance of efficient classroom organisation and highlight the strategies employed by the school to develop a cohesive approach to planning and delivering the curriculum. A number of issues need to be addressed by staff when considering classroom planning and organisation, and these will be discussed in Chapter 7.

Fig. 3.1.1 shows an extract from the Curriculum Statement of Porth Infants School[35]. The aims for mathematics are clear and precise. They set the scene for the development of mathematics throughout the school. The school's philosophy is dependent on the use of discussion as a style of teaching which promotes children's learning. To show that this form of teaching is truly valued, there is a specific aim written into the document:

> "To encourage children to work co-operatively in a group situation and to use discussion techniques to develop and promote understanding".

MATHEMATICAL DEVELOPMENT

The obvious line of development for a primary school child learning mathematics should be:-

ACTIVITY AND EXPERIMENTATION	THINKING AND COMMUNICATING	ACQUISITION OF SKILLS AND REINFORCEMENT

During the infant stage of mathematical development it is hoped to build on experiences gained at nursery stage. Whereas in the nursery stage the children handled and explored a variety of objects and materials(clay, dough,paint, sand etc) now it is hoped to extend these activities and introduce appropriate mathematical vocabulary.
Throughout the infant stage , there should be a stressing of practical work using objects and activities to help children understand mathematical ideas. All new concepts are introduced through practical work and through discussion.There should be emphasis on sound understanding of basic number and once a concept has been understood children should be encpouraged to apply their skills to a variety of situations in every day real life.

Aims : 1. To provide a wide range of experiences and activities from which a child can make global comparisons and develop the concepts of quantity, measure, series and number.

2. To give children the opportunity to think for themselves and to learn with understanding through investigations and practical activities.

3. To allow children to understand the applications of mathematical activities in various situations in the home, classroom ,school and the environment.

4. To ensure that the children enjoy mathematics, have confidence in what they do and that they want to continue the subject later on in their career.

5. To link language development with the extension of mathematical vocabulary.

6. To encourage children to work co-operatively in a group situation and to use discussion techniques to develop and promote understanding.

See Policy Statement for mathematics for further guidelines
See Mathematics Assessment Booklet for detailed objectives covering :-
NUMBER...SHAPE SPACE....MONEY..CAPACITY..WEIGHT..LENGTH
TIME...
With the INPUT of new technology it is necessary to include other very important areas for development.
USE OF CALCULATORS AND COMPUTERS
See Information Technology (I.T.)

Figure 3.1.1: Extract from Curriculum Statement of Porth Infants School

One of the most important yet challenging tasks of school management is the creation of a high motivational climate. Teachers have a vital and essential part to play in the development of the school's curriculum statement and policy documents, and successful teamwork will depend upon creating conditions in which the staff needs are identified and catered for. Day Whiticker and Wren in their book 'Appraisal and Professional Development in the Primary School'[36] identify five sets of needs that are of significant importance in this respect

- a sense of belonging
- a sense of achievement
- a sense of appreciation
- a sense of influence
- a sense of ownership

Such a philosophy for the development of the school's curriculum is shared and supported by Her Majesty's Inspectorate. In their 'Curriculum Matters Series'[37] "The Curriculum from 5 to 16" (The Responses to Curriculum Matters 2), HMI emphasise the benefits that all teachers are afforded by contributing within the teamwork which is necessary for curriculum planning, policy development and school review.

> "...It should be informed by a **shared** view of educational aims or purposes of learning and needs to take account of four complementary perspectives: areas of learning and experience, subjects, cross-curricular themes, and elements of learning".
>
> (page 8, para. 4)

Before considering how a school might set out to plan its curriculum, it is necessary to consider issues which may affect its success. The most demanding

challenge teachers face is that of matching the curriculum to each child's development and providing a differentiated curriculum suitable to the needs of the individual child. Considering the great variation in the way a normal child develops (both physically, mentally and emotionally) this is by no means an easy task. The true strength of a teacher's armoury of skills is measured by the ability to respond to these stages of development and to provide a curriculum dependent more on developmental than chronological age.

In their document "The Whole Curriculum"[38], CCW highlight some of the issues which need to be considered when providing a differentiated curriculum:

> "Children must have appropriate opportunities to work, and learn, as individuals. A major consideration in planning the curriculum for individuals is the issue of **differentiation**. The curriculum must be differentiated in terms of the level of work or task set for individual pupils at the pace of teaching. All pupils, including those with special needs and the most able, should be progressively challenged by the activities provided. This requires an awareness of their previous experience and a professional assessment of pupils' existing knowledge, understanding and skills. The maintenance of systematic records of pupils' achievement is essential".
>
> (page 17, para. 3)

The Schools Council Working Paper 70[39] "The Practical Curriculum" presents the Schools Council's contribution to the debate on the curriculum. It emphasises the need for there to be an agreed structure for the curriculum and discusses the problems of **planning** a curriculum, achieving a **balance** between the various elements, and **monitoring** what is being done. This view is supported by the DES in the paper "Better Schools"[26].

"To serve these purposes the Government believes that the curriculum offered to every pupil whether in an ordinary school or a special school should be:

- **broad:** it should introduce the pupil to a wide range of knowledge, understanding and skills;
- **balanced:** each part should be allotted sufficient time to make its special contribution, but not so much that it squeezes out other essential parts;
- **relevant:** subjects should be taught so as to bring out their applications to the pupils' own experience and to adult life, and to give due emphasis to practical aspects;
- **differentiated:** what is taught and how it is taught need to be matched to pupil's abilities and aptitudes".

(page 4, para. 6)

Her Majesty's Inspectors' survey "Primary Education in England"[12] pointed out how rare it was for primary teachers with a special responsibility to exercise it effectively.

"In a quarter of the schools in the survey teachers with positions of curricular or organisational responsibilities were having a noticeable influence on the quality of work in the school as a whole. In the remaining schools there was little evidence that the influence of teachers with curricular responsibilities spread beyond work in their own classes".

(page 37, para. 2)

The Report goes on to suggest that children's work benefited only when the designated teacher planned and supervised agreed programmes of work. Assigning a responsibility has no value in itself, unless the teacher to whom responsibility is assigned exercises a strong lead in planning and carrying out the programme.

Irrespective of the approach a school adopts in terms of its planning and co-ordination, there is a need to ask how it will decide whether those responsible are having a significant and helpful impact on the pupils' work.

In order to assist schools in implementing the National Curriculum and to meet the requirements of the Education Reform Act in a balanced and coherent way, CCW[38] has identified the following issues which schools need to consider in their planning:

> "• the **aspects of learning** which together describe the whole curriculum; and
> • the **themes, competences** and **dimensions** which, when taken with the statutory and other subjects, give the curriculum coherence and relevance".
>
> (page 6, para. 2.3)

It is suggested that in order to plan a broad and balanced provision for pupils schools should consider the curriculum as comprising eight aspects of learning which describe the full range of experience to which pupils are entitled. These aspects are categorised as:

- expressive and aesthetic;
- linguistic and literacy;
- mathematical;
- physical and recreational;
- scientific
- social and environmental;
- spiritual and moral;
- technological

In developing skills and knowledge in these areas, schools should plan and structure the curriculum as a whole:

> "The aspects are themselves inherently 'cross curricular' in that different subjects will contribute to more than one, if not several, of the defined aspects. Looking at the curriculum in these terms rather than simply from a 'subject' perspective, will emphasise the essential 'wholeness' of the curriculum and the ways in which its different elements interact".
>
> (page 7, para. 4)

In considering the planning of the whole curriculum, it is recommended that schools develop **themes, competences** and **dimensions** so that pupils can experience a curriculum which genuinely promotes personal and social development. CCW describe **themes** as elements of learning to which pupils will need access to if they are to take an active and informed part in the world at large. Suitable areas for consideration are considered to be:

- careers education and guidance;
- community understanding;
- economic and industrial understanding;
- environmental education;
- health education.

It is recommended that schools ensure appropriate provision for these in their teaching, possibly through the use of "thematic" or topic based work.

Competences are to be fostered in a range of contexts which allow for the development of skills in:

- communication;
- the use of information technology;
- numeracy;
- problem solving;
- studying;

while **dimensions** allow for the development of pupils' attitudes, and include:

- the fostering of sympathetic awareness and understanding of the **cultural diversity of society**;
- provision of **equal opportunities** for all pupils irrespective of gender, ability or cultural and ethnic background;
- catering for the **special needs** of pupils in ways which make the curriculum accessible to all pupils;
- demonstration of the **cultural relevance of the curriculum to its Welsh setting**.

3.2 CLASSROOM ASSESSMENT AND THE CURRICULUM

Classroom assessment is at the heart of all good teaching and should become an integral part of the curriculum planning process. It should inform the teacher about the developmental needs of the child and be seen as the means by which teachers gain insight into learning. Consequently teaching and assessment

are inextricably linked in a way that means the process of assessment is an essential element of effective teaching. HMI[31] acknowledge this inter-dependence and note that:

> "It should identify individual pupil's strengths and weaknesses, contribute to planning the next steps in their learning, and lead to further diagnostic assessment where necessary; it should involve them in discussion of their work and in self appraisal; and it should inform the pupils, parents and others, such as employers, of their progress and performance".
>
> (page 11, para 38)

An awareness of the child's knowledge and understanding provides the basis for the learning opportunities which can be offered to them. The link between assessment and curriculum is thus vital to the quality of teaching and learning and this link is the reason why the TGAT Report[40] placed such emphasis on the role of assessment in providing feedback/feedforward in relation to teaching and learning.

The TGAT Report suggests that any system of assessment should satisfy certain general criteria and notes in particular that:

- assessment should give direct information about pupils' achievements in relation to objectives - they should be **criterion referenced**;
- assessment should give direct information about pupils further learning needs - they should be **formative**;

- scales or grades should be capable of comparison across classes and schools. In order to be meaningful, teacher, pupils and parents need to share a common language and common standards - assessments should be **moderated**;

- the ways in which criteria and scales are set up and used should correspond to expected routes of educational development. They should provide **continuity** and be capable of measuring **progression**.

Teacher Assessment should thus make a positive contribution to curriculum planning and review. Promoting children's learning is a principal aim of schools, and assessment lies at the heart of this process.

By making assessment an integral part of the educational process schools can:

- provide a framework in which educational objectives can be set;

- chart pupils progress;

- plan for the next stage in response to children's needs;

- enhance professional skills and strengthen learning across the curriculum and throughout various age ranges.

The National Curriculum and the related assessment procedures provide schools with the major challenge of assessing pupils through a combination of

teacher assessment and standardised assessment tasks. The relationship between assessment and learning can be a very positive one, but it can also be extremely damaging if it is not handled carefully. The most effective means of providing a coherent and consistent assessment policy is by adopting a 'whole school' approach. This serves to link the various parts of the school curriculum by a common monitoring and evaluative process. It further serves to allow senior management to take a strategic overview of the school curriculum and its assessment.

Schools vary dramatically in their approaches to delivering the curriculum. No ready-made approach to assessment can be devised to suit every individual school's needs. Each school must tailor its assessment policy in response to its unique learning environment. However, there are common issues and specific areas of concern that schools need to take into account in order to develop a comprehensive and effective procedure for evaluating its curriculum. In particular, there needs to be opportunity for:

- **formative assessment:** so that the positive achievements of a pupil may be recognised and discussed and the next steps planned;

- **diagnostic assessment**: so that difficulties in learning may be identified and appropriate remedial help provided;

- **summative assessment:** so that schools can report the overall achievement of pupils in a systematic and consistent way.

In addition, three fundamental notions need to be kept in mind when planning for assessment:

- **Fitness for purpose** - deciding **why** it is necessary to assess and for **whom** the assessment is intended, so as to match the assessment techniques to the target group.

- **Validity** - ensuring that assessment intentions are legitimate ones and that they mirror and sample an appropriate range of concepts.

- **Reliability** - ensuring that assessments are consistent so that similar standards are being applied throughout the school, county or country.

In establishing quality in assessment, validity and reliability are key issues that schools need to address. Pupil performance will vary for a number of reasons. Personal factors such as health, home circumstances and temperament could have a detrimental effect on a child's performance. Teacher performance could also be affected by similar personal problems. Other factors may also affect the outcome of the assessment. Teachers may not have the necessary expertise in handling assessment techniques or in choosing an appropriate strategy to complement the particular teaching style employed. Consequently teachers should use a variety of techniques to gather assessment information, and should use both formal and informal methods.

Formal methods of assessment usually involve specially devised tasks with specific criteria. These tasks require a formal structure for administration and are designed with a view to securing information which exhibits a degree of accuracy

and consistency. The Standard Assessment Tasks fit into this category. However, although the SAT's offer reliability in terms of standardisation, they only provide a 'snapshot' of what the child knows, understands and can do at that particular time. In many instances teachers have questioned the validity of these tests, and concern has been expressed as to whether they achieve what they have been designed to do. There is also the question of interpretation of statements of attainment and the evidence produced by the child. Informal methods usually involve a more flexible approach and often teachers' judgements can be clouded by personal involvement, and consequently informal assessment should be balanced by formal methods. Opportunities to improve validity and reliability can be addressed by producing guidelines for the development of a consistent approach. Assessments should be made on several occasions and the context that these are placed in should be varied. Teachers should find opportunities to corroborate assessment with evidence derived from significant sources. The evidence collected possibly in the form of annotated samples of work and photographs should be selected for a purpose and enable the teacher to plan the next stage of development of the child. Samples of pupils' work could form the basis for school based INSET in which teachers moderate and agree on criteria for selection and interpretation of statements of attainment. Agreement trials set up for the purpose of agreeing common interpretations will improve the quality of assessment and the comparability of different assessors within the school. Using such a strategy will ensure that decisions relating to pupil performance will become more reliable and will serve to ensure consistent standards are met.

3.3 A MODEL FOR CURRICULUM DEVELOPMENT

Curriculum development needs to be seen as an integral and continuing part of educational policy and planning. In order for the curriculum to be implemented effectively there needs to be an inbuilt process of evaluation and an overall strategy for monitoring progress. Figure 3.3.1 represents a simplified view of the processes involved in such a strategy. This model is one that the author has developed in some detail during the course of the present research.

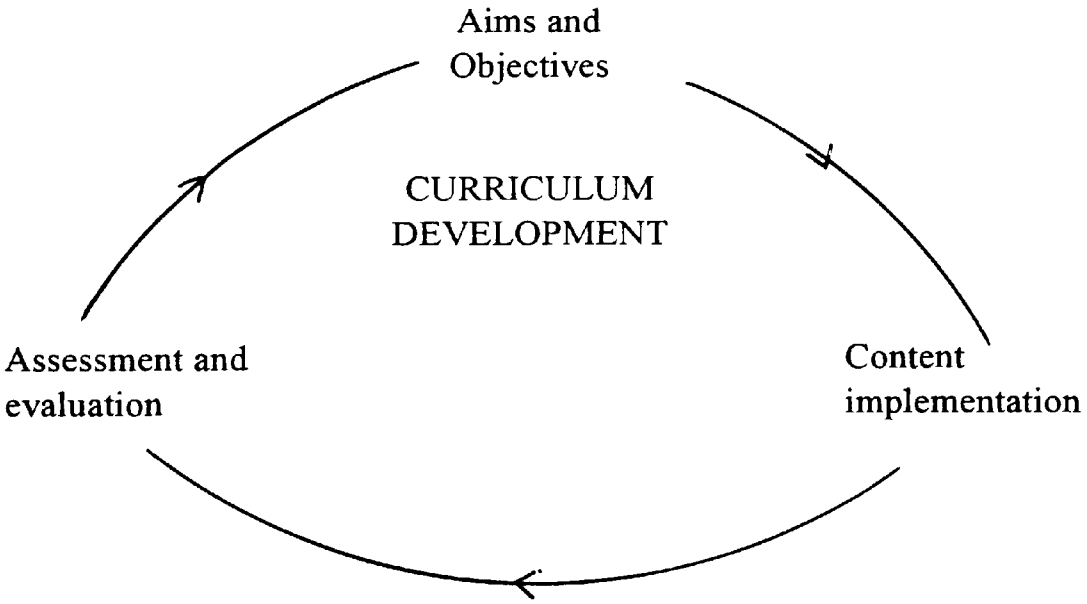


Figure 3.3.1: Model for Curriculum Development

The work which led to this model is described in detail in Section 3.4 and was carried out at a time when the author was headteacher of a small infants school in Mid Glamorgan. At all times the approach adopted was consonant with the philosophy set out in Section 3.1. Clearly within the planning of the school curriculum there needs to be 'written statements' addressed to teachers which direct

the teaching and learning process across the whole curriculum. These statements or policies need to consider:

i) the fundamental purpose underpinning pupils' educational and personal development in relation to classroom practice and effective leadership;

ii) the school's philosophy and strategies for translating and delivering the curriculum from theory into practice;

iii) the balance between the guidance and direction given within each statement;

iv) the rate of change of the work of the school in a rapidly changing world - particularly between what is taught and what children learn from direct experience in the outside world.

In developing policy there needs to be a realisation that the process is not definitive but is sensitive to review and modification, while it is sensible to structure the documentation that is necessary in some hierarchical manner. Figure 3.3.2 indicates a suitable strategy and shows the relationship that exists between a school's curriculum statement, its policy statements, and its schemes of work.

When developing a policy statement it is important to give adequate consideration to:

(i) the management of the exercise;
(ii) the content of the policy;

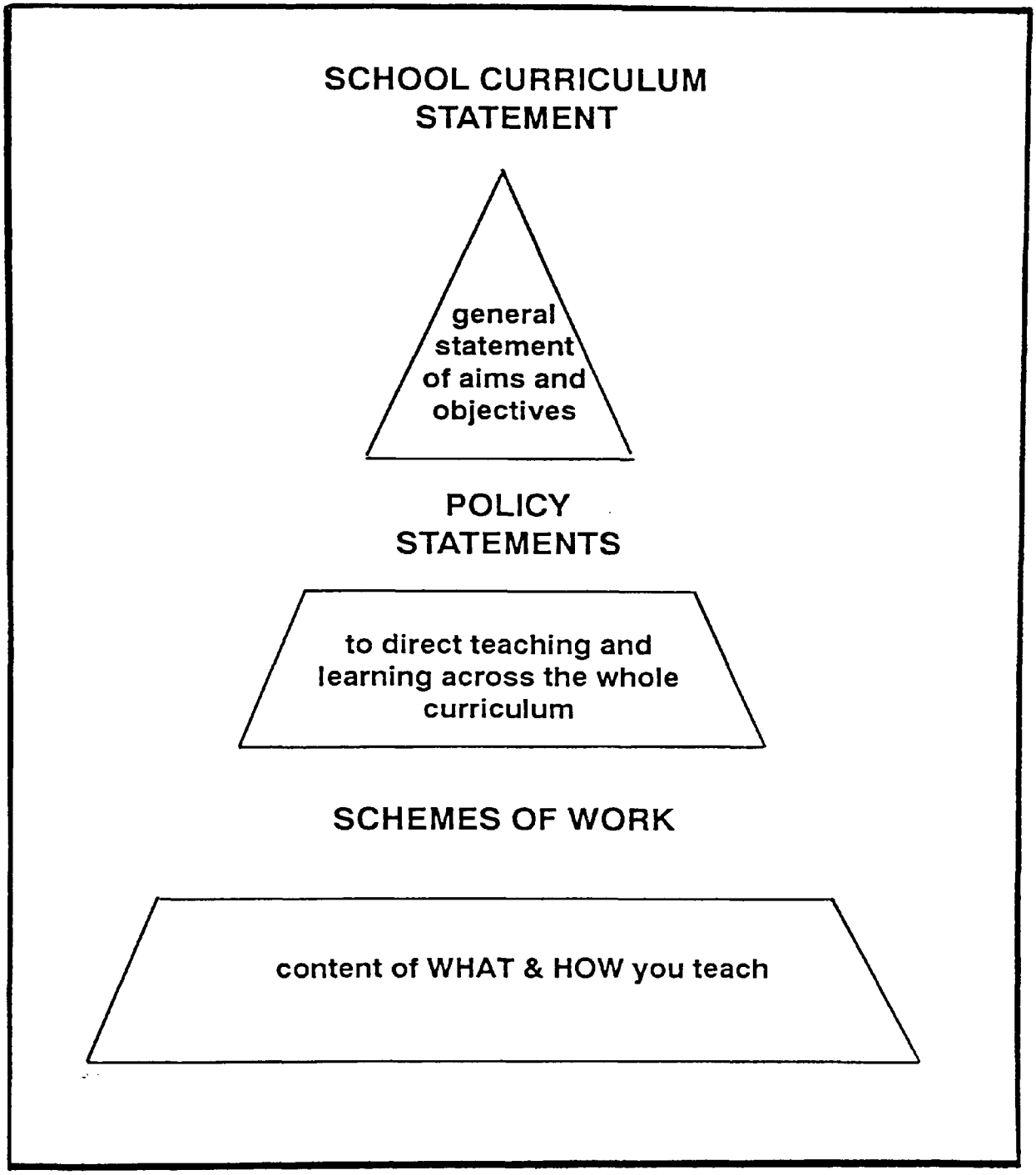


Figure 3.3.2: Relationship between the Curriculum Statement, Policy Statements and Schemes of Work

(iii) issues related to implementation, assessment and evaluation procedures.

As with all effective developmental procedures, it is necessary for teachers to review the current provision. Having identified a need for development, existing problems need to be analysed and priorities discussed. There should then follow a trial period during which work can be assessed, reviewed and refined. The resulting policy statement should be institutionalised and regularly reviewed considering the changing needs of school, staff and pupils. It is essential that all members of staff contribute and that the viewpoint of each member is valued so that a consensus of opinion is reached.

Guidance for planning and designing a model for building a school policy is discussed by Whiticker and Wren[36] who endorse the view that policy making is best achieved through the involvement and active participation of all staff. In addition, it is suggested that appropriate timescales need to be allocated and that policy making is best achieved by following a systematic approach in which leadership is seen as the function of a staff team rather than as a function of a key individual.

3.4 REVIEWING A SCHOOL POLICY STATEMENT - A CASE STUDY

Before formulating in detail an interactive learning package for mathematics, the author found it necessary to review the school policy statement for mathematics. Similar reviews were deemed necessary for other areas of the curriculum and the actual development work undertaken spread across all subject boundaries. In order to refine and update existing materials it was necessary to

secure the support of all staff and to obtain their agreement to hold regular meetings. During these meetings policy statements were formulated for the three core subjects of Science, Mathematics and Language (see Figure 3.4.1) and for each of the foundation subjects. Policy Statements were also produced for other broader areas such as Parental Involvement, Classroom Organisation, and Discipline.

A significant outcome of these meetings was the production of a 'quick reference sheet' which enables teachers, parents, governors and advisers easy access to

- the aims of that particular policy;
- the methods that were to be used for its implementation;
- the evaluation procedures that were to be adopted.

An example of such a reference sheet is shown in Figure 3.4.2. Specific aims are written in the first column, with ways in which these aims can be implemented in the middle column. Finally, a third column provides teachers with access to the evaluation procedures.

It soon became apparent that there was opportunity to plan and develop this form of recording throughout all policy statements (see Figure 3.4.3). Positive outcomes identified included:

i) continuity throughout the curriculum;

ii) easy access;

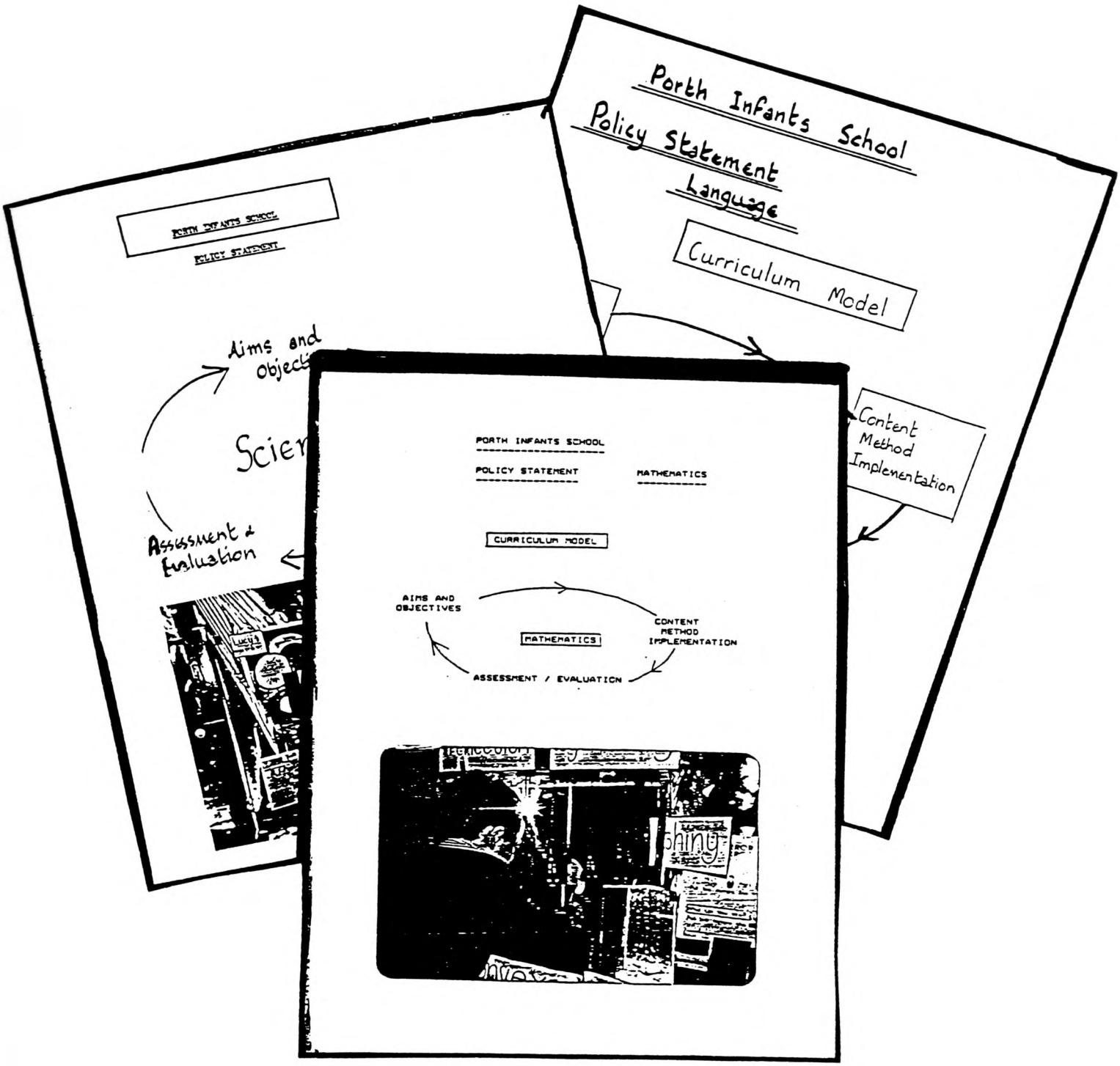


Figure 3.4.1: Policy Statement Booklets

AIMS	IMPLEMENTATION	ASSESSMENT / EVALUATION
I. To develop lively enquiring minds.	By providing a stimulating environment within which the child is encouraged to develop through exploration in an 'interactive' learning situation.	Through on-going evaluation of our provision of adequate science equipment and different situations. e.g. ...by response from children by response from staff by response from 'Science Co-ordinator'
2. To encourage children to pose questions and devise experiments to answer those questions. (We believe that children should be encouraged to form their own conclusions from their own experiences)	By organising the classroom to provide situations with resources that will encourage the child to investigate, question and predict.	As above.
3. Through practical investigations of the environment it is hoped to foster a healthy respect for everything that is living.	By encouraging the children to take a pride in looking after the immediate environment around the school. To develop a loving , caring approach to looking after 'pets' . It is proposed that every classroom should have a pet.	By observation of the children's attitudes towards their pets and each other.
4. To encourage children to design and carry out their own investigations, providing them with the opportunity to interpret results and findings and to apply their skills in mathematics and language.	By providing opportunities for the children to demonstrate and apply their skills in all areas of the curriculum e.g. presenting work in science through art and craft, written, reporting, mathematics, P.E. , Drama etc.	By keeping examples of children's work, photographs, in science across the curriculum Continued.

Figure 3.4.2: Extract from Policy Statement for Science

AIMS	IMPLEMENTATION
1. To give children the opportunity to think for themselves and to learn with understanding through practical activities and investigations.	By encouraging children take an investigatory approach to mathematics. Careful thought needs to be given to the organisation of group work and the teacher's role in encouraging "mathematical thinkers" (see Discussion Based Teaching Document)
2.To provide a wide range of varied experiences and activities from which a child can make global comparisons and develop concepts of quantity, measure, series and number.	Through planned programmes of work including theme linked mathematics.Work should be planned on a fortnightly basis and linked to the development of the child. The classroom organisation should support interactive learning.
3.To allow children to understand the applications of mathematical activities in various situations in the home,classroom,school and the environment.	By encouraging children to apply their skills to everyday real life problems. Carefully planned themes and cross curricular developments will provide children with opportunity to apply their mathematical skills. (see Home/School Tasks)
4.To ensure that children enjoy mathematics, have confidence in what they do and that they want to continue to learn the subject.	By ensuring that work is matched to the child's stage of development. Through discussion activities developing a positive attitude by showing each child that we value what they say.
5.To link language development with the extension of mathematical vocabulary.	By carefully planning and structuring the introduction of important vocabulary e.g. At Nursery...match,sort,set equivalent, less than etc. At Infant...difference,addition symmetrical etc. Also positional and descriptive vocabulary. N.B. DISCUSSION allows each child to develop and improve his linguistic skills.
6.To encourage children to work co-operatively and share their ideas and to use discussion to help promote understanding.	Through activities that allow the children to develop social skills.Children should be encouraged to follow a process of building and testing ideas partly by refelection (own) partly by discussion.

ASSESSMENT AND EVALUATION

The school assessments for mathematics have been formulated through staff discussion and participation. They provide a scheme of work that encorporates the attainment targets of the National Curriculum , while at the same time offering opportunity for assessment that is objective based and geared to the development of the child.
(See Assessment Booklet for Mathematics, also, Assessment Policy Statement)
N.B.
To supplement the Assessment guide there is a"paper" on guidelines for teacher assessment.

Parents are regularly invited to "Parents Meetings" to discuss their child's progress with the teacher.These meetings are held approximately three times a year and at the meetings parents have access to their child's records. It is essential that all staff are aware of the importance of such meetings and that they welcome the opportunity to offer help, guidance, advice and support to parents who are concerned in any way. If there are problems then the parents should be encouraged to work with the teacher to help benefit the child.

At the end of KEY STAGE 1, Parents will be invited for a summative report of their child's achievements throughout his stay in the Infant School. To help teachers with this reporting, a "Record of Achievement Folder" will be kept. This folder will include "dated" work of the child and his specific assessment records for every area of the curriculum. Parents will also be told the LEVEL that their child has reached in the three main core subjects - Mathematics, Science and Language.

Figure 3.4.3: Extract from Policy Statement for Mathematics - Porth Infants School

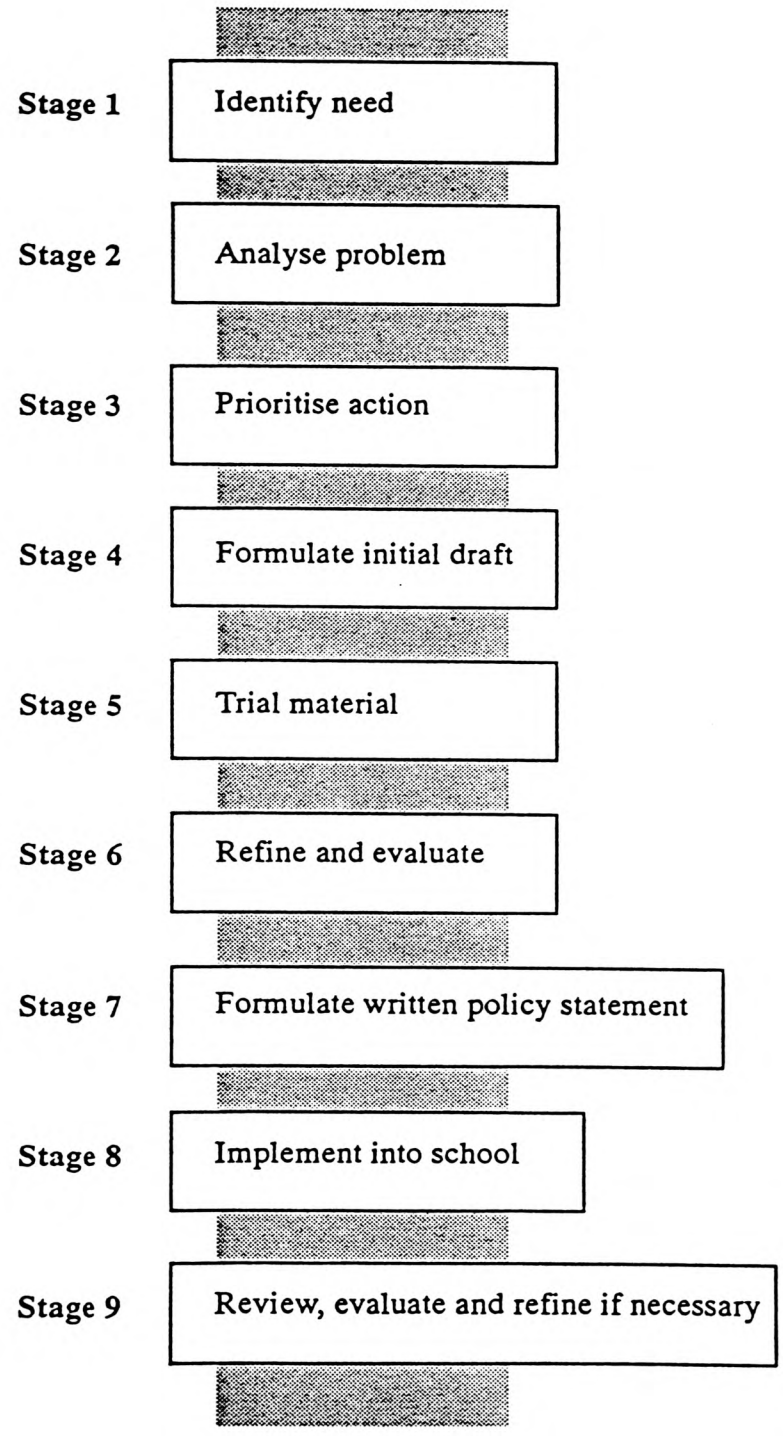


Figure 3.4.4: A Summary of Processes Adopted During Policy Making

iii) a positive approach to curriculum delivery since all staff were involved in development and decision making from the earliest stages.

The processes developed for policy making ensured that members of the 'team' worked towards a common agreed goal and committed all those involved to the implementation of the agreed strategy. The stages of development are summarised in Figure 3.4.4, while the written product, although produced through consultation, was prescriptive in tone and detailed in nature.

3.5 THE MATHEMATICS DOCUMENT

Having carried out a detailed review of the school's mathematics policy and produced an objective-based document for assessment purposes (see Appendix A), the research work was overtaken by the publication of the National Curriculum Statutory Orders for Mathematics[41]. This required a re-examination of the school's new documentation in order to identify any weaknesses or omissions which might be in evidence in relation to the National Curriculum. The Attainment Targets for 'Number' and 'Measures' were cross referenced into the existing scheme and consideration was given to exactly what areas were not being covered. It soon became apparent that the school's assessment procedures actually covered a more detailed range of activities than those specified in the National Curriculum. These additional stages or **enabling targets** were considered to be necessary steps on the way to a child achieving a National Curriculum Attainment Target. The review process also identified some National Curriculum areas that were not being covered, and some that were covered but not recorded for assessment purposes. An important example was Attainment Target 2 (level 3).

- read, write and order numbers to at least 1000; use the knowledge that the position of a digit indicates its value;

- use decimal notation as the conventional way of recording in money;

- appreciate the meaning of negative whole numbers in familiar contexts;

It was felt that this was not appropriate for many Year 2 children but nevertheless there was now a statutory requirement for a record to be included in the assessment document. Other areas of mathematics, such as 'Functions' and 'Handling Data', had always been included in the schools mathematics scheme of work but written records had not always been kept for assessment purposes. Consequently, the mathematics scheme of work was re-written and a revised assessment document produced[42]. Every member of staff was provided with a copy of this booklet, which included updated objective-based activities, and was designed to allow teachers to assess through their everyday teaching programme.

The teaching programme at Porth Infants is planned across the whole key stage (see Chapter 4 for outline details). Its prime concern is with the acquisition of knowledge, skills and understanding which enable the child to progress in mathematics. The National Curriculum model is intended to reflect this philosophy, and although the National Curriculum document appears to fragment the subject matter via a series of 10 levels this does not pose a major problem for a school which has engaged in long-term planning. Consequently, the publication of the Revised Orders for Mathematics,[43] although requiring some cosmetic changes to the assessment document in terms of the new numbering of attainment

targets, did not necessitate any fundamental revision. The 'Number' assessment sheet which was produced to accompany the updated assessment document (see Figure 3.5.1) has a grid at the top of the page showing the broad stages through which a child would normally pass. These are colour coded from red to gold and within each category there is a stage-related series of enabling steps which are described in Chapter 4. These steps correspond to the numbers shown at each level on the "brick wall" below the grid, which are correspondingly colour-coded. The levels defined in the AT's of the National Curriculum can be identified within these enabling steps, as shown in Figure 3.5.1. Children progress through these stages as members of an ability group. The teacher plans each group's work schedule over a two week projection based on their perceived needs. Because the activities are criterion-referenced the teacher can make a judgement, supported by discussion and observation, on whether or not a child has understood the various concepts involved and when a child is ready to progress to the next stage of the learning programme. Clearly, the teacher can also make a judgement about whether a particular level in the National Curriculum has been confidently attained.

This form of curriculum planning is supported by the non-statutory advice offered by the Curriculum Council for Wales[44] which advocates that children's work in mathematics should be planned across a complete key stage or, where possible, the whole primary phase. The programmes of study in place at Porth Infants, and the experience gained in carrying out the reviews described above, suggest that any future National Curriculum revisions could be incorporated without any fundamental change of philosophy.

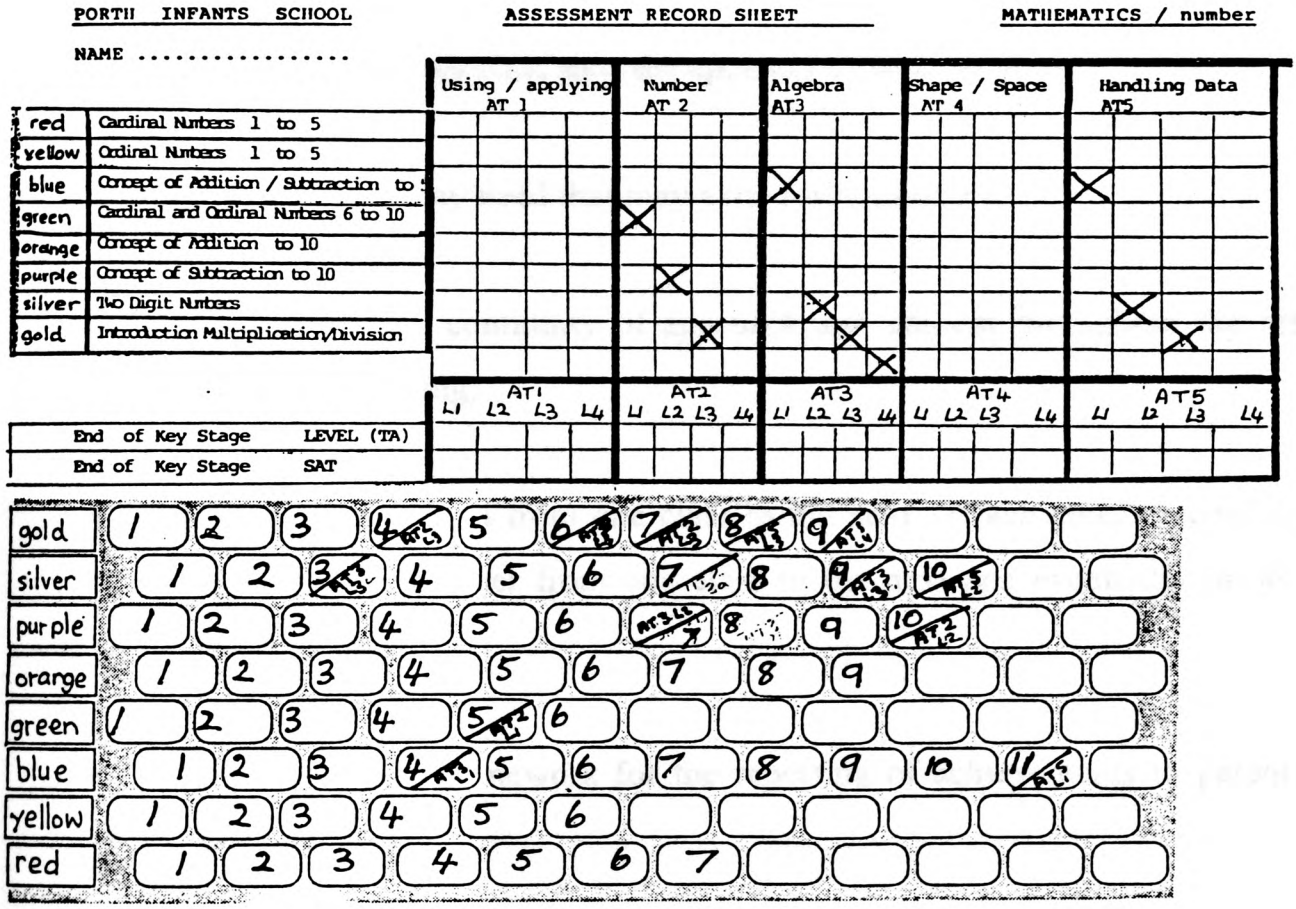


Figure 3.5.1: Individual Assessment Sheets for Number and Measures

The assessment document that has evolved provides an effective means of recording and reporting children's progress. Throughout Key Stage 1 each child's assessment sheet is updated on a regular basis and the records so generated provide the following advantages:

- they allow instant access to the child's level of mathematical development;
- they allow teachers to identify the next stage in the child's development thus ensuring that each child gets the appropriate level of work;
- they highlight any need that may exist for regrouping;
- they encourage continuity of approach and content throughout the infant stage of schooling;
- they ease transition from one class to the next. (Each child's record sheet accompanies him/her from one class to the next and eventually on to the junior school);
- they provide a framework for the reporting of achievements to parents at 'open evenings'.

CHAPTER 4

INTERACTIVE LEARNING ACTIVITIES

4.1 INTRODUCTION

The research and literature reviews of Chapters 1 and 2 enable us to identify certain pre-requisites for effective classroom learning. The children need to:

- be actively involved in their learning;
- make choices, take decisions and become independent;
- develop respect for themselves and the individuality of others;
- feel secure and valued;
- use language effectively.
- be able to discuss and reflect upon their experiences so that they are able to negotiate a fuller understanding of the ideas involved.

For mathematics, more specific objectives can be identified. Pupils need to develop and use mathematical vocabulary with understanding, so as to:

- describe properties of shapes or numbers, for example, triangular, round, even, prime ...

- relate one object to another using, for example, "same as", "different from", "more than", "less than", "higher than", "above" ...

- make sense of information and instructions;

- give their own instructions and information;

- explain their own, and follow others' explanations of results and methods.

To implement such a philosophy we need to plan and structure activities which can be used on an individual, group, or class basis. The activities described in this chapter were designed to meet the above requirements, and also to encourage teachers to reflect upon ways in which children learn, and provide a framework in which assessment techniques can be developed. They form the basis for an interactive learning package which supports the teaching of mathematics across Key Stage 1, delivered through a discussion approach. These activities are discussed more fully in the next section, including their relation with the various stages of Key Stage 1.

During the initial planning stages it was necessary to address a number of practical issues:

- Each activity needed to be self-supporting to allow the teacher to deal with other children within the classroom as necessary.

- The activities needed to be carefully planned with clear starting points and well defined aims.

- Planning needed to take account of the resources that would normally be available in an infant classroom. The apparatus used should be appropriate and enhance the activity.

- The children needed to know that they would be expected to talk and contribute to the discussion.

- The children would also need guidance on **when** to listen to others and when to allow other children to put forward their point of view.

In order to evaluate the activities and to gain first-hand practical insight of the ways in which children learn, it was decided to observe in detail the progress of one group of children. This allowed close monitoring of the activities and the group interaction which resulted. Detailed examples are given in Chapter 5. As the activities were refined they became part of the classroom resource base and all children were given access to them.

4.2 DISCUSSION-BASED ACTIVITIES

The discussion-based activities which have been developed are designed to be used as part of a structured teaching programme planned across key stage 1. The activities fit within the general stages of development which are identified within the Porth Assessment Booklet (see Appendix A) and which are colour-coded.

During the first or **Red Stage** of the child's mathematical development, children will be sorting sets, counting and matching number names and numerals with a collection of objects. Pupils should be able to make reasonable estimates of a small number of objects and understand and conserve number no matter how members of the set are arranged.

At the **Yellow Stage** children will be putting sets in order with the use of numerals 0 to 5. The child should be able to compare the cardinality of sets (number of members of one set with the number of members of another set) and use vocabulary such as more than, less than, equivalent, first, second, ... fifth.

The **Blue Stage** requires children to acquire number bonds to 5 through activity and practical experience. At this stage children will be working 'towards addition' and meet the concept of subtraction. Activities involve number stories to 5 and the use of structured apparatus. Emphasis is placed on the development of number patterns such as 1+1 = 2; 1+2 = 3; 1+3 = 4, or 5+0 = 5, 4+1 = 5, 2+3 = 5, 1+4 = 5 and 5-1, 5-2, 5-3, 5-4, etc. The children will also engage in a variety of counting activities which require them to put two sets together and use a number line to count forwards and backwards. Pupils are expected to add and subtract to 5 without the use of apparatus before going on to the next stage.

During the **Green Stage** pupils are encouraged to develop an awareness of numbers 6 to 10. Activities are similar to those described for the Red Stage but demand the use of numbers up to 10. Calculators are introduced and estimation forms part of the ongoing number programme.

The **Orange Stage** provides opportunity for children to develop skills in addition to 10. Practical activities involve handling data and require pupils to use their newly acquired number skills to read and interpret information. Opportunities are provided for developing an understanding of the use of Block graphs, Carroll Diagrams and Venn Diagrams.

The **Purple Stage** extends ideas associated with subtraction to the use of numbers 0 to 10. Each child should be able to talk about number statements and interpret and apply number in practical situations. In particular, pupils are expected to recognise and use statements of the type

$7+3 = 10$ and $3+7 = 10$.

$7 > 3$ and $3 < 7$ by 4.

$7 + \square = 10$ and $\square + 3 = 10$.

At this stage of their development children use "Function Machines" to explore number relations and to carry out simple investigations. Before the children complete this stage they must be able to add and subtract to 10 without the use of apparatus, and be able to recall the number facts without help.

The **Silver Stage** involves work on place value and the use of two digit numbers. The child is required to understand place value in the context of tens and units and solve addition and subtraction problems to 20. Number pattern work includes the use of the Function Machine with children exploring their own operations and using numbers greater than 10. Patterns will include:

$4+10 = 14$; $14+10 = 24$; $24+10 = 34$ ....

$4+10 = 14$; $4+20 = 24$; $4+30 = 34$ etc.

and children are required to carry out surveys in the classroom and develop methods of recording data. Mental agility is encouraged and valued, as is sensible use of the calculator.

The **Gold Stage** focuses attention on the processes of multiplication and division. Children are provided with a wide range of experiences in

recognising and counting equivalent sets. They will have practical experiences in developing an understanding of the commutative law and that division is the inverse of multiplication. Children are expected to investigate number with the use of a calculator and are expected to construct and interpret bar charts and graphs (pictograms). Many activities at this level involve the use of dice and ideas associated with probability are discussed.

The discussion activities themselves evolved from a variety of starting points with reference being made to the 'ongoing' assessment sheets which had been produced (see Chapter 3). Thus the level of mathematics being taught was matched to the stage of development of the child within the group. Whenever possible the activities were designed so that they could be adapted to fit into the class teacher's theme. However, if a particular piece of mathematics needed to be developed which did not fit conveniently into this category, an appropriate activity was still pursued.

Each activity was cross referenced into the existing teaching programme at the appropriate colour-stage of the assessment document (see Fig. 4.2.1). This figure provides an indication of the coverage and opportunities for learning provided. A brief description of each activity follows.

Red Stage **Cardinal Numbers 1 to 5**

Sort the Teddy Bears

This activity provides the children with the opportunity to develop mathematical vocabulary in an enjoyable setting. The group use knitted teddy bears as a resource for sorting into sets. The bears were produced as the result of a home school task and the children were encouraged to sort the bears using their own criteria. Criteria for sorting could include colours (red, yellow, blue,

COLOUR STAGE IN MATHEMATICAL DEVELOPMENT	NAME OF ACTIVITIES
RED STAGE: **CARDINAL NUMBERS 1 to 5**	• Sort Teddy Bears • Teddy Bears (Match the Set)
YELLOW STAGE: **ORDINAL NUMBERS 1 to 5**	• Grab a Group • Leapfrogs • Moving Toys
BLUE STAGE: **CONCEPT OF ADDITION/ SUBTRACTION 0 to 5**	• Change your Sets
GREEN STAGE: **CARDINAL/ORDINAL NUMBERS 6 to 10**	• Calculator Fun • Make 10p
ORANGE STAGE: **ADDITION 6 to 10**	• Dice Game • Addition to 10 • Rainy Days • Eyes • Calculator Houses
PURPLE STAGE: **CONCEPT OF SUBTRACTION 6 to 10**	• Odds and Evens • Talking Photographs • Calculator House Game • Patterns • Make a Set • Carroll diagram • Grab a Group (2) • Cubes and Cuboids • Make 10p/15p • Machines 1
SILVER STAGE: **TWO DIGIT NUMBERS**	• Food for Thought • Strips • Dinner Time
GOLD: **INTRODUCTION OF MULTIPLICATION/DIVISION**	• Strips • Reflections • Design a Symmetrical Model

Fig. 4.2.1 : Activities Cross-referenced into Mathematics Assessment Document

brown), size (big, small) or a variety of other attributes (with clothes/without clothes, with scarves/without scarves).

Teddy Bears (Match the Set)

This is an extension to the first activity and provides the opportunity to match numerals to sets. The teacher can develop the activity further by changing one of the sets, for example by adding an extra bear. This encourages children to extend their thinking to consider the different aspect of two sets.

Yellow Stage **Cardinal Numbers 1 to 5**

Grab a Group (Activity 1)

Grab a Group is a game devised to develop skills in estimating. The starting point relates to estimating small numbers and initially the children were challenged with the question - "Are these more or less than 10?" As the activity progresses the children are encouraged to develop their own strategies to help them develop skills in estimating. Further work involving the checking of estimates can produce some interesting work in number and number pattern.

Leapfrogs

The Leapfrog activity is a game which encourages the development of strategies. The game can be used by children of varying abilities and differentiation can be identified in terms of the outcomes observed. This activity indicates how children can be working in different areas of mathematics at one time. Here the starting point was related to developing mathematical thinking. However, as the activity develops the children are required to apply their number skills to the situation and to consider ways of recording their results. In order to address these issues some of the children are working within the purple stage of their development.

Moving Toys

Moving Toys is a science based activity that encourages children to apply skills in sorting using their own criteria. The resources (toys that move) are brought from home by the children and displayed in the science investigation. The group are encouraged to sort the toys according to how they move.

Blue Stage **Concept of Addition/Subtraction (1 to 5)**

Change your sets

This activity presents the children with the challenge of changing their sets to suit the number. By being involved in this process children are developing skills associated with the operation of addition. Children also experience the difference aspect of number.

Green Stage **Introduction of Cardinal/Ordinal Numbers 6 to 10**

Calculator Fun

The first part of this activity is designed to encourage recognition of numbers formed on a calculator display. Further work involves introducing the children to number investigations using the calculator. For example, the group may be given the task of producing the numbers (1 to 5) on the display using only the keys = + - 2 3. such activities encourage children to use the calculator to develop their understanding of the processes of addition and subtraction.

Make 10p

The aim of this activity is to give the children practice in using addition and subtraction skills in the context of money. The game provides practical experience with coins of value to 10p. A game board is provided and each child has a purse to put their money in. This activity is described more fully in Section 5.2 where it is used to exemplify teacher assessment in action.

Orange Stage **Concept of Addition (6 to 10)**

Dice Game

The aim of this activity is to provide experience of number bonds to 10 in an enjoyable game situation. Cards with numbers 2,3,4,5,6,7,8,9,10 are placed in rows of three and the children take turns to throw two dice and add up the score. The card with the correct answer on is turned over. The first to turn over three in a row wins a point. This activity is referred to in Section 6.1, page 127, where it is used to discuss teacher intervention strategies.

Addition to 10 game

This activity involves the use of dice to reinforce number bonds to 10. The teacher can also use the activity to develop early ideas associated with probability by asking the children to find out how many ways there are of making 3 etc. This work is a preliminary to number patterns.

Rainy Days

Rainy Days is a cross curricular activity that enables children to apply their skills in handling data and using and applying mathematics. The activity originated from a science investigation designed to consider different types of materials and their properties. The children choose which material they think will be best for a hat which is to be worn in rainy weather. The children are encouraged to investigate by setting up a fair test. The group represent their results in an appropriate manner, possibly by constructing bar graphs or sets.

Eyes

This activity involves carrying out a class survey. The children are asked to choose something measurable to survey. The monitored group chose 'eyes' and produced three different forms of recording information.

Calculator Houses

This activity enables children to develop their understanding of number bonds and the operations of addition and subtraction. The children are required to make number statements which they can check using a calculator if desired. The activity is referred to in Chapter 6, Section 6.1, page 160, where it is used to emphasise the advantages of valuing children's contributions in group discussion.

Purple Stage **Concept of Subtraction (6 to 10)**

Odds and Evens

This activity focuses on odd and even numbers. There is an opportunity to play a game in which each child chooses to be an odd number or an even number. There is also opportunity for the children to develop skills in pattern making.

Talking Photographs

The aim of this activity is to develop mathematical vocabulary in an interactive learning situation. The resources used as the 'Talking Maths' photographs which provide discussion points for the children. Appropriate teacher intervention provides opportunities for the children to extend their mathematical thinking and use of language. This activity is referred to in Section 6.2 where it is used to show how teacher strategies can be incorporated into classroom planning.

Calculator House Game

This activity is similar to Calculator Houses and allows children to perform and produce different outcomes.

Patterns

Here children are involved in using and applying their skills in pattern making in the context of Shape and Space. The group are asked to use coloured 2-dimensional shapes to make a symmetrical model. Follow-on work involves using mirrors and recording results for display purposes. The children are encouraged to use appropriate mathematical vocabulary to describe the properties of their shapes. This activity is used in Section 6.1 to illustrate how planned teacher strategies can support classroom organisation.

Make a Set

This activity requires the children to describe the properties of three-dimensional shapes and to sort them according to their own criteria.

Carroll Diagram

This is an extension activity to Make a Set. The children use poleidoblocks and take turns to place them in the relevant sections of a Carroll diagram. This activity has proved particularly effective in encouraging group interaction and providing enjoyment.

Grab a Group (Activity 2)

Grab a Group (2) is designed to allow each child the opportunity to estimate a number of cubes (multilink) and to use the cubes to sort into sets using Carroll diagrams. Large charts with section headings already written on, e.g. PRISMS/NOT PRISMS and ORANGE/NOT ORANGE are provided.

Cubes and Cuboids

This activity allows a group of children to develop skills in making three-dimensional shapes using junk materials and clixi apparatus. The monitored group began with a practical session in which they made cubes and cuboids out

of clixi apparatus. They then explored various ways of making nets. Finally the group were given a task to complete at home in which they were required to investigate the number of different ways they could find to join six squares together and which of these could be used as a net to make a cube.

Make 10/Make 5

This activity deals with addition and subtraction facts and provides opportunities for the children to make decisions about the difference between numbers.

Machines 1

This is an introductory activity to functions and the notion of input/output machines. The children are encouraged to talk about machines they may have encountered, such as chocolate machines in which the money goes in and the chocolate comes out, before considering machines which process numbers.

Silver Stage **Two Digit Numbers**

Food for Thought

Food for Thought is a theme related activity that allows children to develop skills in weighing and handling data, as well as concepts associated with the early stages of probability. Initially the children are asked to carry out a survey to find the favourite meals eaten by children in the class. The sample group used a variety of methods to record their results and found the most popular meals to be boiled potatoes/chips, peas/beans, beefburgers/sausages. The study group were then given an extended investigation designed to find out how many different meals could be made from these foods. To help the group it was decided to make the food out of playdough and to use this representation to physically make as many different combinations as possible. The activity also included a visit to the local shops to buy ingredients, and a cookery session

to weight and make the food. The group used the good they made to determine how many individual portions they could serve.

Dinner Time

Dinner Time continues the work begun in Food for Thought and provides the group with the opportunity to record their findings. Resulting evidence can be displayed in the classroom and discussed with the rest of the class.

Gold Stage **Introduction of Multiplication and Division**

Strips

The purpose of this activity is to encourage the children to think more deeply about the properties of two-dimensional shapes. The group have opportunity to make shapes from strips of card. Some interesting number work evolves when the teacher asks the group to find out if they can make a square from any number of strips of card.

Reflections

This activity is intended to reinforce children's knowledge of reflective symmetry. The sample group produced an attractive display for the classroom wall. A permanent investigation area was set up in Porth to allow all groups to investigate reflections using a variety of resources which include mirrors.

Design a Symmetrical Model

This activity allows the children to use their knowledge of symmetry to design a model. Techniques used in Design and Technology can be exploited and the group should be encouraged to plan their models on squared paper. All of the sample group enjoyed this activity, with positive results emerging. Sample photographs were taken during the session and these were used when reporting

to parents. The final plans were used as a classroom resource for further activity and other groups enjoyed following them to construct models.

The activities outlined above were developed and trialled at regular intervals over a two-year period, and records were kept of the following aspects:

- the interaction within the group;
- individual contributions to discussion;
- teacher intervention;
- the strengths and weaknesses of children in order to allow for future planning;
- the understanding demonstrated of the concepts involved.

During the process of cross-referencing the activities into the school's assessment schedule, it was noted that the interactive nature of the activities allows the children freedom to explore other areas of mathematics at a range of levels, e.g. Moving Toys addresses objectives within the Yellow and the Purple Stages as there are opportunities for the children to develop skills in sorting, making sets and handling data. Furthermore, the package of activities has a dual use. It affords learning experiences with built-in opportunities for formative assessment. Alternatively it can be used to provide opportunities for focused assessment. The bank of activities can be added to as teaching progresses. Experiences which have been identified as valuable can be recorded so that the package becomes developmental and benefits teachers as well as pupils. Thus the package provides teachers with a selection of activities enabling them to develop concepts and assess understanding in a variety of contexts.

The information obtained when trialling the early activities was used to plan later learning experiences. It was also used to develop guidance in the use of the package which would enable teachers conduct the activities more effectively. Clear aims were produced for each activity and the way in which the activities were structured allowed the children flexibility to become involved in their own learning. This approach allows teachers who wish to make use of the package:

i) to clearly identify specific mathematics to be developed;
ii) to collect appropriate resources to develop the activity;
iii) to plan the method and organisation of the session to allow for flexibility;
iv) to record teacher assessment of the **talk** and make professional judgements through the **talk**;
v) to evaluate the activity;
vi) to plan the next stage of learning.

During trialling of the developing package children were encouraged to think about what they were doing and to communicate their thoughts to other group members. The opportunity to interact and share ideas was encouraged and resulted in visible improvements in the quality of learning. The children developed confidence and enjoyment ensued with positive results. The use of talk as an important tool for learning was considered paramount, and children soon came to realise for themselves the value of discussion. While trialling the activities it soon became apparent that certain learning skills were embodied in each of them. These skills include the ability to:

- participate as speakers and listeners in a group activity;
- respond to instructions;

- describe events and communicate observations.
- work collaboratively in a group;
- give and receive criticism;
- argue for and against in a logical way;
- show respect for others and their contributions;
- work with confidence and demonstrate perseverance;
- use appropriate materials for a task;
- talk about work and ask questions;
- make predictions based on experience;
- explain work systematically;
- make and test predictions.

Having identified this list of skills the opportunity was taken to cross reference them into the programmes of study for mathematics. The ability to cover more than one aspect of the curriculum had the added bonus of facilitating classroom planning and curriculum coverage. Figure 4.2.2 shows an evaluation framework based on the above list of skills. It is particularly useful for teachers wishing to target specific skills from the list during a session using a particular activity. The framework could also be used to focus on recording individual pupil's interaction within the group. These aspects will be developed in detail in Chapter 5.

4.3 MONITORING PROGRESS

As well as producing a set of discussion-based activities, the research aimed to supplement them by developing materials which enable teachers to monitor the progress of individual pupils within a group situation. In order to build up a picture of each child's development through the activities, a number of recording procedures were used. These included:

	Is there opportunity for pupils to:	
Linguistic and Literacy Development: • participating as speakers and listeners in a group activity; • responding to instructions; • describing events and communicating observations.	• discuss their work with colleagues; • develop skills in discussion;	**Comment**
Social and Emotional Development: • working collaboratively in a group; • giving and receiving criticism; • arguing for and against in a logical way; • showing respect for others and their contributions; • working with confidence and demonstrating perseverance.	• work collaboratively in a group; • show respect for others and their contributions; • develop positive attitudes;	
Mathematical Development: • using materials provided for a task; • talking about their own work and asking questions; • making predictions based on experience; • explaining work systematically; • making and testing predictions.	• develop knowledge and understanding of mathematics; • devise skills in using and applying;	

Figure 4.2.2: Outline Framework for Evaluating Skills

- detailed notes based on observation;
- written details of the discussion which occurred;
- photographs of work in progress;
- completed samples of work in written, diagrammatic and visual form;
- use of a cassette recorder.

Evidence was collected throughout the key stage so that it would be possible to provide a summative report on each child within the chosen group. In particular, evidence was collected that showed significant progress, indicated achievement and/or highlighted strengths and weaknesses. Detailed notes based on teacher observations were produced and photographs were used to enhance the quality of the records kept. Photographs of children taking part in the activities had a highly motivating effect on the children, and increased their confidence, sense of importance and self esteem. Transcribing the dialogue, although time-consuming, proved to be a worthwhile activity as it afforded a permanent record of the interaction for evaluative purposes. This is referred to positively in the guidance for teachers and emphasises the need for reflection. The use of audio resources proved helpful and the children enjoyed the added bonus of being able to listen to their own contribution on the tape recorder.

The record keeping sheets produced as a result of this study enable teachers to focus their attention on the difficult problem of gathering evidence to support teacher assessment. The information obtained when trialling the sheets was used to plan future activities and seemed to improve the quality of teaching provided. The development and use of these sheets will be dealt with in detail in Chapter 5, and exemplified through the use of case study material. By monitoring the children in this manner a record-keeping system can be developed which gradually builds up a picture of the individual child's

development in mathematics, identifying progress and highlighting achievement. With this emphasis on an **on-going** programme of mathematical activity, teacher assessment becomes developmental rather than merely focusing attention on achievement at an isolated moment in time. The resulting judgements made by the teacher are more likely to be reliable, rigorous and to give a true picture of what the child knows, understands, and is able to do. Teacher assessment in this context will allow children to fulfil their potential, allow the teacher to determine what the child has learned, and identify the most appropriate challenge for the pupil to undertake next. Collecting and reviewing evidence of children's learning provides basic information for **reporting** pupil achievement, while assessments made over a series of activities enable teachers to evaluate and modify the curriculum.

Well-thought-out teacher strategies at each stage of the assessment process will serve to enhance teaching and learning. Chapter 6 focuses on the role of the teacher and discusses the development of such strategies.. Wherever possible the strategies seek to maximise teachers' time with pupils. Evidence gathered from trialling the strategies has shown that effective organisation is essential to release the teacher from the task of managing the rest of the class while working with groups at mathematics. With this condition established we can consider those aspects of learning that lie at the heart of a discussion approach, where it becomes apparent that teachers need to use a variety of skills to gather information. This information can then be used to make decisions about pupil performance and the appropriateness of the activities being used so that a differentiated curriculum can evolve. A curriculum that caters for the needs of every child will generate the intended learning outcomes. However, these outcomes need to be planned and structured to allow systematic observation to take place.

The model shown in Fig. 4.3.1 illustrates this form of teacher assessment in action. Initially teachers are required to plan structured learning activities or experiences which support the programmes of study to be covered. At classroom level the teacher will be involved in gathering evidence, making judgements and recording progress. The evidence collected will be recorded onto the school's on-going assessment record sheets and will serve a variety of purposes. It can be used to plan the next stage of learning, report to parents, and build up a picture of the progress and development of the child.

At the end of the key stage schools have a statutory obligation to report levels identified by teacher assessment and standard assessment task results. The Welsh Office Circular 69/92[45] "Reporting Pupil Achievements in 1993" clearly identifies a school's legal requirements. At present the teacher needs to:

- complete teacher assessments by the required date in the 3 core subjects of mathematics, English and science, as well as the other foundation subjects;

- arrive at common standards;

- administer standard assessment tasks/tests;

- keep accurate and up-to-date records of teacher assessment on all attainment targets in each subject;

- retain evidence to support teacher assessment that will satisfy the requirements for consistent standards;

- complete record forms for each pupil accurately by the required date;

- report the results to parents by the end of the Summer Term according to the statutory regulations.

The quality of teacher assessment throughout the key stage is vital to the effectiveness of this statutory requirement as well as being part of everyday teaching and learning in the classroom. To meet the statutory requirements teachers must collect, select, update and annotate evidence of pupil achievement throughout the key stage. Reporting levels in isolation is meaningless unless it is seen in the context of the overall development of the child. Reporting progress and achievement to parents needs to be part of an ongoing process so that a partnership can develop between the home and the school. A meaningful dialogue needs to be established through parental conferences held during the school year and culminating in a final summative report at the end of the key stage.

Fig. 4.3.1 provides an overview of such a process. It exemplifies the ongoing nature of Teacher Assessment and highlights the relevance of the **process** in relation to the **product** or summative report at the end of Key Stage 1. Implementing such a philosophy requires planned learning experiences and opportunities for gathering evidence and recording progress. The teachers' judgements form the basis for future planning to take place. Reporting is credited with quality evidence which supports teacher assessment and the whole process can be monitored and evaluated to 'feed forward' and improve the quality of future teaching and learning.

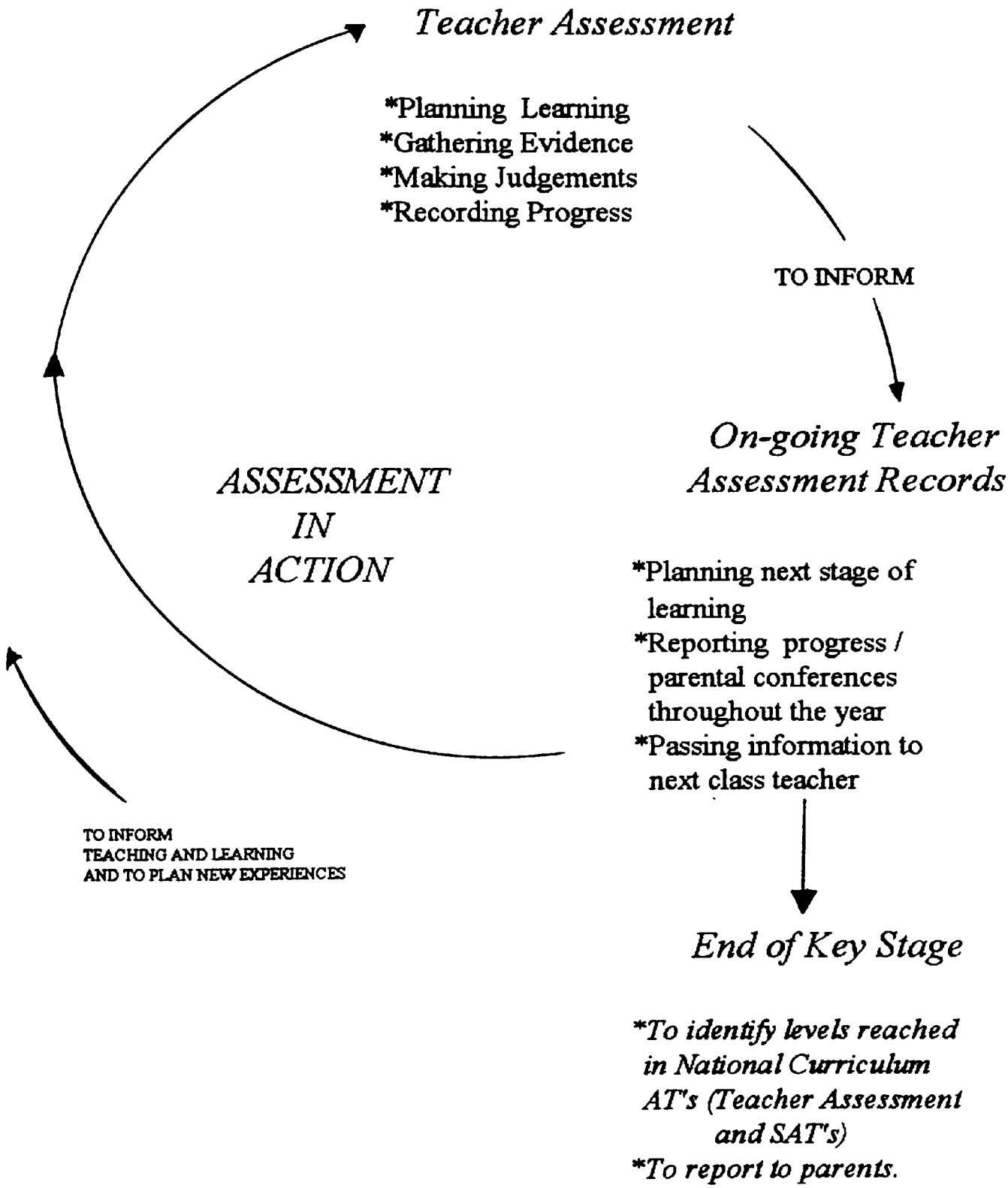


Fig. 4.3.1 : Assessment in Action

4.4 IMPLEMENTING A DISCUSSION-BASED APPROACH

A major ingredient in the success of a discussion-based approach is the planned and structured in-service training of all staff. Opportunity for review through staff consultation and evaluation is essential if learning is to be managed effectively. A whole-school approach will support this process and should encourage classroom practice to provide continuity of experience throughout. Clear strategies incorporated into policy guidelines will encourage successful teamwork. Such policy making will ensure that members of the team work towards a common agreed purpose and that the people involved in the decision making will put their decisions into practice. Chapter 7 discusses some of the issues associated with the formulation of a whole-school policy for assessment, recording and reporting through school-based INSET. The chapter considers classroom management and the ways in which schools can carry out reviews to assess where they are in relation to their provision for discussion-based teaching and the development of skills to support a discussion-based approach.

Most primary school teachers have a responsibility for a particular area of the curriculum and have an important role in supporting colleagues. As curriculum leaders they are likely to be responsible for initiating and delivering school-based INSET. All schools are different, and the range of circumstances and needs is wide. The planning of INSET will need to take account of the professional expertise of the staff and the ability to deliver an appropriate action plan that would recognise these qualities while at the same time reflecting the individual needs of the school. Chapter 7 considers the development of school-based INSET with the starting point identified as the school review. In order to help curriculum leaders to plan a review, the framework illustrated in Figs. 7.2.2 and 7.2.3 was developed. These source

sheets provide curriculum leaders with an excellent resource which can be used to encourage colleagues to identify needs, reflect on ways to improve current practice, and evaluate progress.

CHAPTER 5

TEACHER ASSESSMENT

5.1 RECORDING PROGRESS

The process of gathering information concerning a child's performance during a practical activity and then translating this evidence into a value judgement involves the use of a variety of teacher skills. During the development of the pupil activities this issue was given considerable prominence. At the classroom level, recording progress during a practical activity has always proved difficult because of the ephemeral nature of the task. In situations such as these, keeping evidence of oral communication has had a low profile in schools. In order to give the assessment of oracy added status in the eyes of teachers and parents, the record sheets 1 - 4 (see Figs. 5.1.1 to 5.1.4) were produced.

In order to clarify recording procedures, it became necessary to identify the differences between 'teacher records' and evidence of pupils' learning. By focusing specifically on the nature of the 'teacher record' and identifying what evidence would be needed to support the teacher record, it soon became apparent that there was a need to:

- link the evidence of a particular pupil's progress to the relevant record kept by the teacher;

- ensure that the record contained **all** of the relevant information which relates to the evidence collected;

- ensure that evidence and records are accessible and meaningful to pupils and others who may require them;

- develop a system that is manageable.

Other issues included the need to develop:

- a coherent balance between what is planned and learned and the evidence recorded;

- a balance between a recording system that is manageable for the teacher and yet comprehensive in relation to the information it contains on pupil achievement;

- a recording system that is evolutionary so that it can be monitored, reviewed and adapted according to changing circumstances and the needs of the school.

A written record of observations and assessments made during a practical activity provides evidence of pupils' learning. An emphasis on language and discussion encourages children to value 'talk' and become more aware of their own use of language. This provides invaluable information about children's understanding of concepts and about the success of the learning activities themselves. To support such a philosophy the author has developed the record sheets (Figs. 5.1.1-5.1.4) referred to earlier. These will now be described along with a summary of their main uses.

EVALUATION SHEET SHEET 1

ACTIVITY
NAMES OF CHILDREN
CURRICULAR AREA
APPARATUS
ORGANISATION
EXAMPLE OF DIALOGUE
COMMENTS

Fig. 5.1.1 : Sheet 1 - Evaluation

The evaluation sheet (Fig. 5.1.1) was initially designed for record keeping purposes. The sheet is divided into three main sections:

1. General information about the activity and those involved. The information includes the curriculum area to be developed, the apparatus required, and useful guidelines about organisation.

2. A section for the teacher to provide an example of the dialogue the activity generated.

3. A comment box for specific teacher observations to be recorded.

After trialling the sheet with a variety of activities over a period of three weeks, the process involved in completing it highlighted its potential for:

- providing opportunities for teacher reflection;
- making specific observations about children's learning in a variety of contexts;
- keeping a permanent record of the discussion so that future planning could take place;
- use in other areas of the curriculum, e.g., science, technology, language.

The Quick Evaluation Sheet (Fig. 5.1.2) was developed in order to focus attention on the individual contributions made by the children participating in the activity. The 'speech bubbles' allow an assessment to be made of:

- the child's understanding of the concepts involved;
- the ways in which the child interacts socially within the group;
- the child's use of language.

The comment box provides further opportunity for specific observations to be made.

The sheet was designed to:

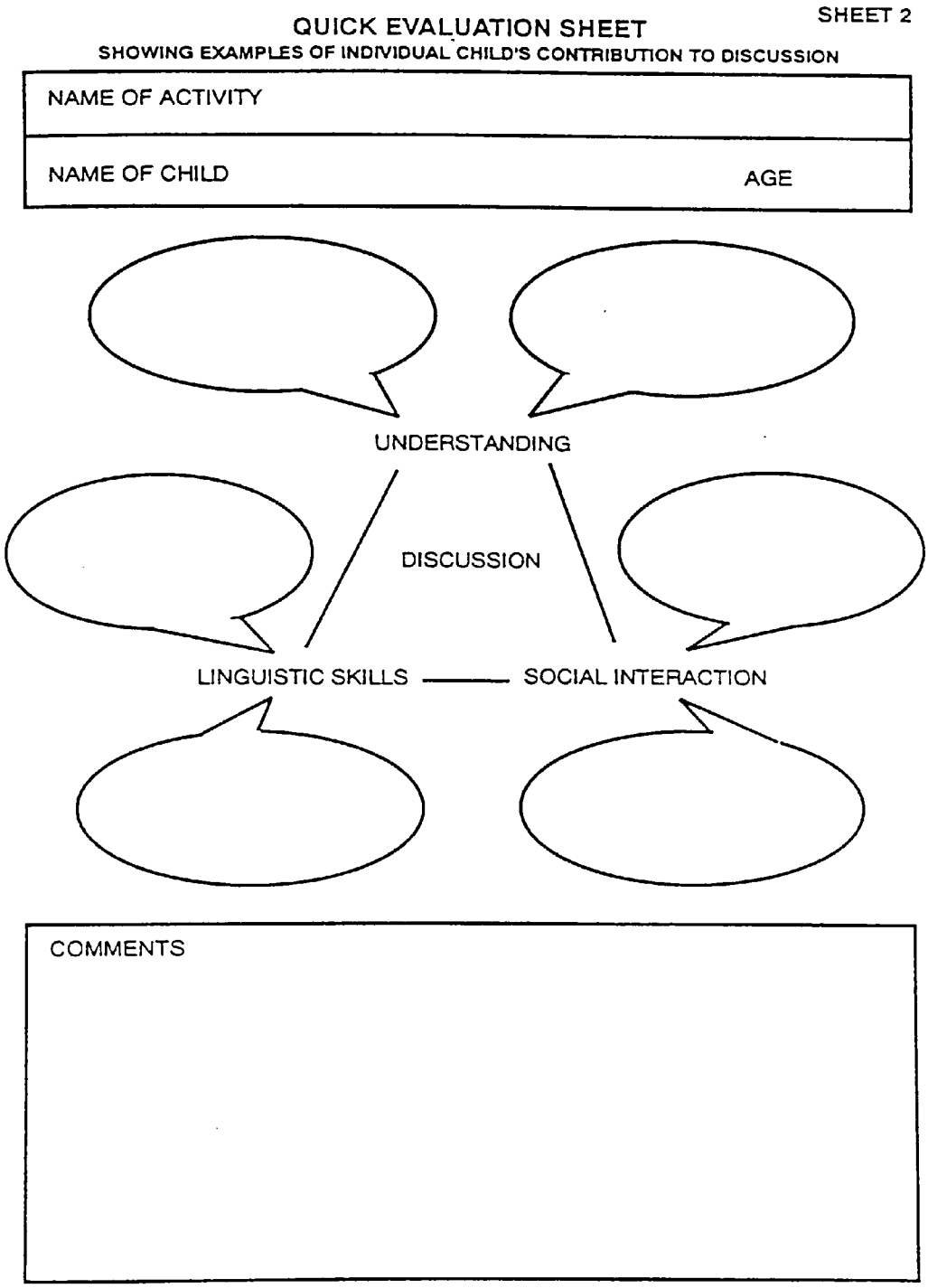


Fig. 5.1.2 : Sheet 2 - The Quick Evaluation Sheet

- allow the teacher to focus attention on the interaction within the group;
- help future planning by providing a permanent record of what each child has said;
- be diagnostic in nature - highlighting strengths and weaknesses.

After trialling the sheet over a period of time, the diagnostic nature of the sheet was recognised and further exploited in the planning of future activities.

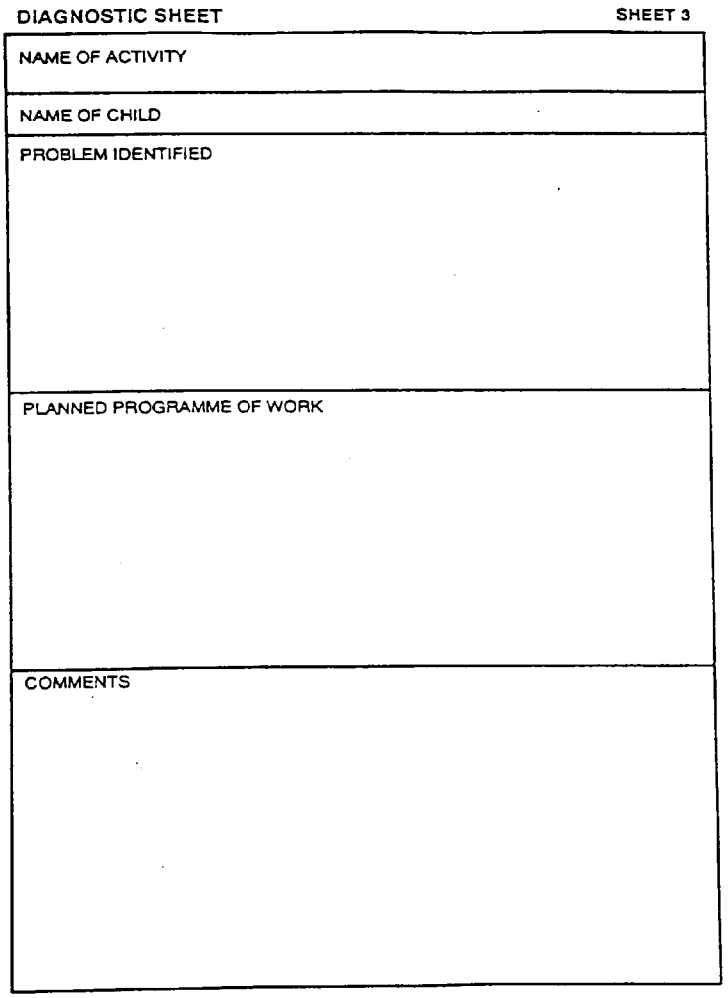


Fig. 5.1.3 : Sheet 3 - The Diagnostic Sheet

The Diagnostic Sheet (Fig. 5.1.3) is divided into three main areas:

1. Identified problem
2. Planned programme of work
3. Comment box

The sheet arose from an identified need to have a record for planning future work based on the particular requirements of each child. By reviewing sheets 1 and 2, particular problems and issues can be identified and then transcribed onto sheet 3. The process involved in completing the sheets can be referred to as 'teacher assessment in action'.

Sheet 3 provides an opportunity for a record to be kept of those children in need of a specific planned programme of work. It is anticipated that only a small number of children will fall into this category.

SHEET 4	ACTIVITY		
NAME OF CHILD	LINGUISTIC SKILLS	SOCIAL INTERACTION	UNDERSTANDING

Fig. 5.1.4 : Sheet 4 - Activity Overview Sheet

Sheet 4 (Fig. 5.1.4) provides an overview of the discussion activity. The purpose of this sheet is to provide an illustration of how each child is performing within the group activity. The columns, under the headings of 'Linguistic Skills', 'Social Interaction', and 'Understanding', encourage the teacher to analyse the dialogue with specific activity-dependent criteria in mind. The sheet originated from the need to have a means for evaluating the effectiveness of the activity as a whole and of the performance of all the pupils within the group. If the sheet is used in conjunction with the sheet described in Fig. 4.2.2, p.91 then there is opportunity to assess particular skills and a written record is available as evidence to support teacher assessment. The sheet provides opportunities for:

- evaluating the effectiveness of the activity;
- assessing the progress of each child, while at the same time comparing that progress with other children in the group;
- recording the dialogue in a systematic way.

5.2 TEACHER ASSESSMENT IN ACTION

To demonstrate how the record sheets were used for recording pupil progress, two case study activities have been chosen:

Case Studies	Curriculum Area		Content
ACTIVITY A 'Moving Toys'	• MATHEMATICS	→	• Shape and space Sorting for own criteria
	• SCIENCE	→	Forces/Materials
	• LANGUAGE	→	Speaking/Listening
ACTIVITY B 'Make 10p'	• MATHEMATICS	→	Money - Addition/ Subtraction to 10
	• LANGUAGE	→	Speaking/Listening

'Moving Toys'[46] is a theme related activity planned to fit into the Science programme of work. The fortnightly projection provided detailed plans of:

- how to set up an investigation area;
- what resources were necessary to enable the children to work with the teacher and unaided;
- learning objectives and criteria for assessment;
- recording procedures.

The investigation area was set up in the 'Science Corner' of the classroom and linked with a 'Home School Task'. Parents were asked to look for a variety of toys which moved in some way. Their contributions were displayed in the area and children had opportunity throughout the term to:

- look at the construction of the toys;
- examine the different types of materials used;
- consider the 'useability' of the items;
- experiment with ways in which the toys moved;
- sort the toys according to a variety of criteria;
- carry out investigations, e.g. races with cars using different gradients, etc.

These tasks offered opportunities for cross curricular work to develop and for the children to apply their mathematical skills. These included:

- measurement ... use of a variety of timing devices/metre rules, tape measures, rulers, etc.
- decision making ... choosing criteria for sorting the toys;

- describing work and checking results;
- asking and responding to questions;
- explaining work and recording findings.

The programme of work was continued throughout the term and stimulated further work in technology. Groups of children planned, designed, constructed and evaluated their own toys. Within this context a coherent learning environment which provided opportunity for continuity and progression for each child was developed.

The following extracts are taken from one group's experience of this discussion activity, and exemplifies the interaction which took place.

Adrian : I think we could sort them into a set of things that do not move and a set of things that do move

Teacher : Could you do that for us Adrian?

Stuart : We haven't got any toys that don't move

Adrian : Oh yes we have, look this doesn't move if you put it up like this

Adrian has picked a barrel shaped toy with flat tops

Adrian : It's a cylinder shape

Rhian : We've got cylinders in our books; not our reading books mind

Victoria : This toy doesn't move because its got a flat bottom

Chris : And it's got a flat top as well

Stuart : If you turn these onto their sides they roll, and if you push it, it can roll too. It's the way you put it in the set that makes the difference. Look, it's got different edges - flat on top and different on the side

Adrian : These all move if you push them (Adrian points to the set with cars, planes etc.)

Nicola : Yes, you've got to push them

Laura : This one rolls funny

Stuart : It's a roly poly bear

Adrian : It's rolling back and fro but it's not moving

Rhian : If you push the car it goes in a straight line

Chris : Some go straight and some go in a line and some go round

Teacher : Who can tell us **how** Adrian has sorted the toys?

Laura : These toys don't move and these toys do move

Teacher : Can we sort the toys in a different way?

Rhian : I'm going to sort them by ...hmm!

Stuart : You could put ones with wheels in there and ones without wheels in there

Teacher : What do you think about that Rhian?

Rhian : I think that's a good idea, it's different to Adrian's way; he put ones which move and ones which don't move

Nicola, Stuart and Rhian quickly sort the toys. Although Nicola has not said very much, she understands what to do.

Teacher : Can you tell us about the sets.

Rhian : These toys have wheels and these toys don't

Teacher : Are there any other ways of sorting? Victoria and Chris, would you like to try

Victoria : What about toys that make a noise and toys that do not?

Chris : Put toys that make a noise in here and the others in that set

Chris and Victoria quickly produce two sets.

Adrian : I've got a smashing idea. Things that roll when you put them on their side but don't roll when you stand them up

Stuart : Let's try that then. But what about the rolling man, he won't stand up

Laura : You'll never get him to stand because he's meant to roll. He's not supposed to stand

Teacher : Well what are you going to do with him then?

Adrian : He won't stand so he's got to go in there

Documenting the dialogue, although time consuming, provided:

- a detailed account of what was said by the children and by the teacher;
- opportunity for reflection to take place;
- opportunity for observations to be noted.

After reflecting on the activity, a number of entries were made on the 'Evaluation Sheet' (see Fig. 5.2.1).

The completed evaluation sheet indicates that this activity was successful and effective in that there was plenty of opportunity for:

- children to be actively involved in their learning;
- making choices and developing their thinking;
- sharing ideas and perceptions;
- valuing other contributions;
- using language effectively.

EVALUATION SHEET SHEET 1

ACTIVITY	MOVING TOYS
NAMES OF CHILDREN	Stuart, Adrian, Rhian, Victoria, Laura, Nicola, Chris.
CURRICULAR AREA	MATHEMATICS / SCIENCE (logical sorting / forces)
APPARATUS	Variety of toys for sorting
ORGANISATION	An area was set up in the classroom to display the toys that the children had brought in. The children worked in this area as a group during Free Choice and Teacher Directed act.

EXAMPLE OF DIALOGUE

ADRIAN : • I think we could sort them into a set of things that do not move and things that do move.
..... oh yes we have look this doesn't move if you put it up like this.
• It's a cylinder shape.

VICTORIA : This toy doesn't move because it's got a flat bottom.

CHRIS : Some go in a straight line and some go in a line and some go round.

STUART : You could put ones with wheels in there and ones without wheels in there.

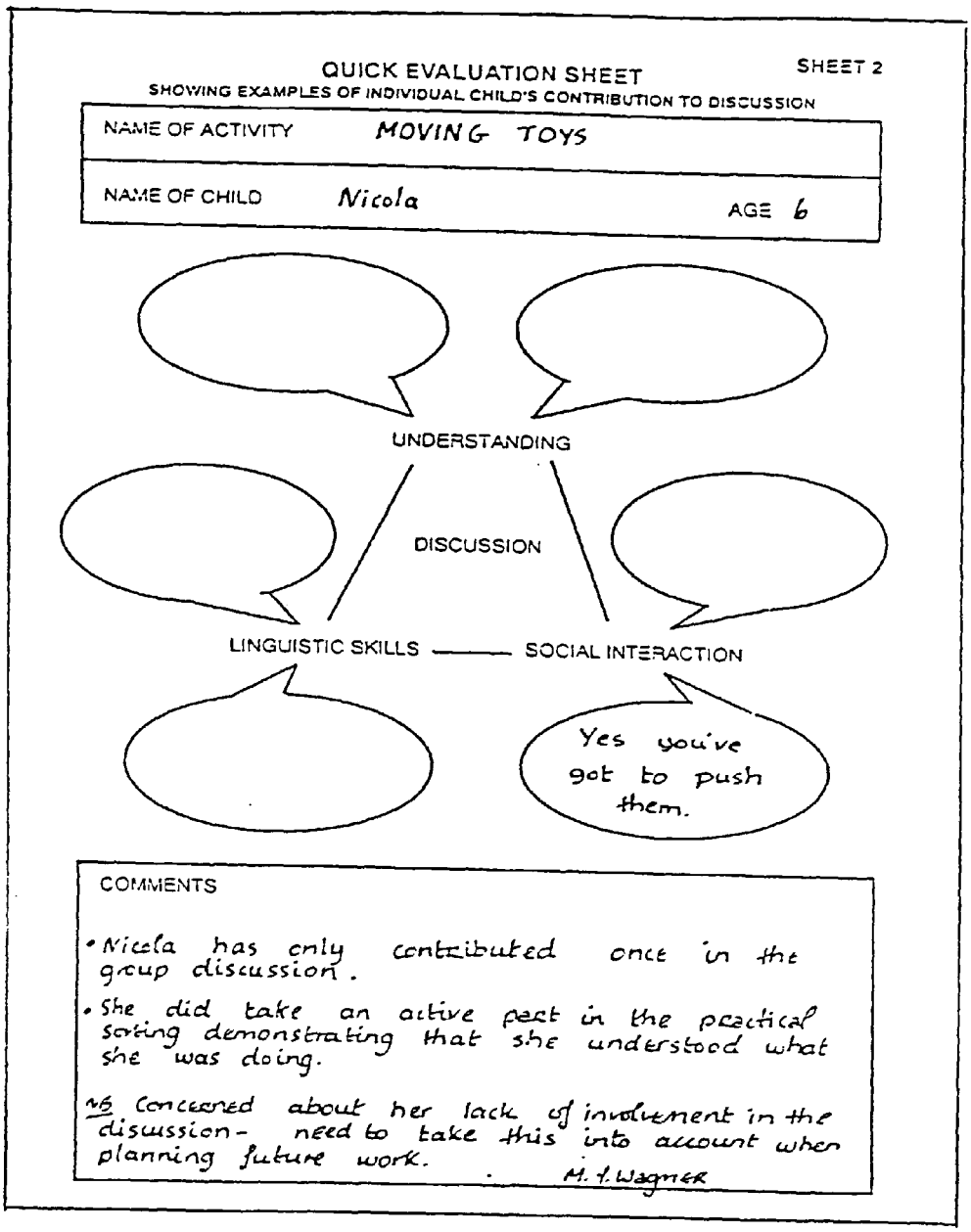
COMMENTS

An interesting discussion with all children demonstating the ebility to sort the toys accecding to their ceiteria.
The context that the activity was placed in pecuided opportunity for:-
(i) quality learning to take place;
(iii) links with and between curriculum areas.
The children (apart from Nicola) were confident in their use of language and applied mathematical vocabulary with success.
Nicola. Although Nicola was able to carry out the task practically - she was very quiet. I plan to take this activity a step further and monitor her role in the next activity.

M. Wagner DATE :

Fig. 5.2.1 : Evaluation Sheet for 'Moving Toys'

The recording of this activity highlighted the sparsity of Nicola's spoken contribution and the possibility of there being a 'problem'. Nicola only spoke once during the activity, although she did the sorting practically. Her lack of oral involvement may have been due to a number of reasons. The 'Quick Evaluation Sheet' (see Fig. 5.2.2) re-emphasised the issue and a diagnostic sheet was completed.



QUICK EVALUATION SHEET SHEET 2

SHOWING EXAMPLES OF INDIVIDUAL CHILD'S CONTRIBUTION TO DISCUSSION

NAME OF ACTIVITY MOVING TOYS

NAME OF CHILD Nicola AGE 6

UNDERSTANDING

DISCUSSION

LINGUISTIC SKILLS — SOCIAL INTERACTION

Yes you've got to push them.

COMMENTS

- Nicola has only contributed once in the group discussion.
- She did take an active part in the practical sorting demonstrating that she understood what she was doing.

NS Concerned about her lack of involvement in the discussion - need to take this into account when planning future work. M. T. Wagner

Fig. 5.2.2 : Quick Evaluation Sheet for Nicola

The diagnostic sheet (see Fig. 5.2.3) provided a permanent record for a plan of action. Having identified a possible problem, a series of strategies were planned to suit the particular needs of the child.

Strategy 1: To monitor the role played by Nicola in the next planned activity.

Strategy 2: To encourage Nicola to contribute more by developing her confidence with praise and encouragement.

Strategy 3: To change the composition of the group, possibly limiting the number to four children.

Strategy 4: To use a game situation that would require Nicola to interact and necessitate her making oral contributions.

DIAGNOSTIC SHEET SHEET 3

NAME OF ACTIVITY MOVING TOYS

NAME OF CHILD Nicola

PROBLEM IDENTIFIED

+Concern expressed about Nicola with regard to :-
(i) interaction within the group;
(ii) oral contribution to discussion.

PLANNED PROGRAMME OF WORK

- To monitor her role in the next planned activity.
- To encourage her to contribute more by developing her confidence with praise and encouragement.
- To limit the number of children within the group to 4.
- To use a game situation that would require Nicola to make a verbal contribution.

COMMENTS

A second Activity (activity B) was planned so that I could focus on Nicola's role within the group.
(see - Make Top ACTIVITY B - for further details)

M. Wagner DATE -

Fig. 5.2.3 : Diagnostic Sheet for Nicola

The process involved in completing the above sheets provoked much thought and indicated a variety of possible reasons why Nicola did not contribute. These include:

1. The effect the other children had in the group may not have allowed Nicola to respond orally. The two boys, Adrian and Stuart, were very articulate and at times in control of the activity. Adrian immediately takes the lead at the start of the activity by saying "I think we could sort them into a set of things that do not move and a set of things that do move" (see Fig. 5.2.4 for Quick Evaluation of Adrian's contribution to the group)

   Stuart also exhibits good use of language by saying "If you turn these onto their sides they roll an if you push it it can roll too. It's the way you put it in the set that makes the difference. Look, it's got different edges, flat on top and different on the side" (see Fig. 5.2.5 for Quick Evaluation of Stuart's contribution to the group).

2. Nicola may not have understood what was happening and therefore did not feel confident enough to contribute. However, throughout the activity Nicola was able to carry out the task practically.

3. Nicola may have been too busy with the practical sorting to feel the need to contribute. The toys were very interesting and Nicola may have been too involved in playing with them.

4. Nicola may not have had anything worthwhile to say.

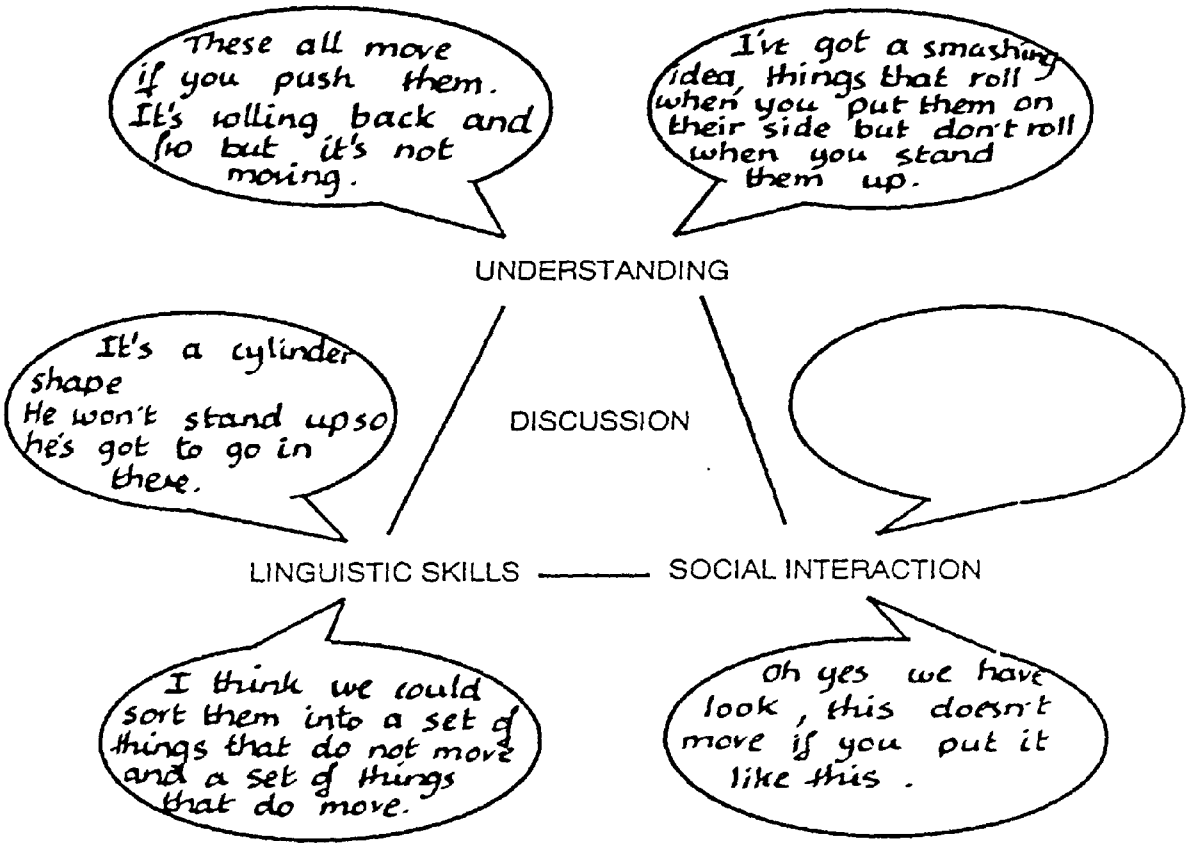
5. Nicola may be developing a 'social' problem which could result in her behaving in a withdrawn fashion.

SHEET 2

QUICK EVALUATION SHEET

SHOWING EXAMPLES OF INDIVIDUAL CHILD'S CONTRIBUTION TO DISCUSSION

NAME OF ACTIVITY	MOVING TOYS
NAME OF CHILD	Adrian AGE 6



COMMENTS

Adrian takes a leading role in this discussion. He has developed sophisticated criteria for sorting the toys.

His use of language is at a high level.

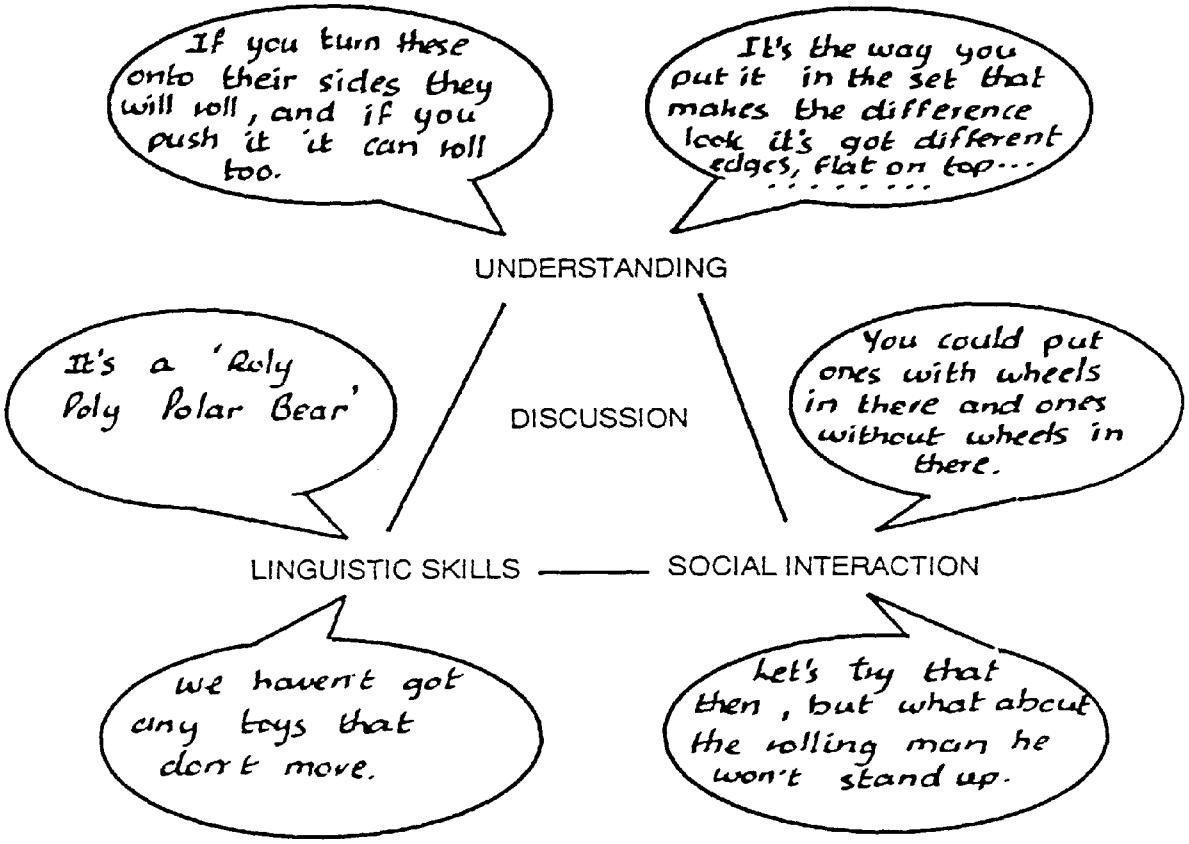
He is very confident in a group situation

Fig. 5.2.4 : Quick Evaluation Sheet for Adrian

QUICK EVALUATION SHEET

SHOWING EXAMPLES OF INDIVIDUAL CHILD'S CONTRIBUTION TO DISCUSSION

NAME OF ACTIVITY	MOVING TOYS	
NAME OF CHILD	Stuart	AGE 6



COMMENTS

Stuart demonstrates that he is competent in the use of oral skills. He also shows that he understands the differences and similarities in objects and that he is able to sort the toys according to his own criteria.

Stuart always works well in a group situation and co-operates with his peers.

Fig. 5.2.5 : Quick Evaluation Sheet for Stuart

As well as providing opportunities for focusing on individual children's needs, the outcomes of the activity have been summarised using the 'Activity Overview Sheet' as described earlier (see Fig. 5.2.6).

SHEET 4	ACTIVITY MOVING TOYS		
NAME OF CHILD	LINGUISTIC SKILLS	SOCIAL INTERACTION	UNDERSTANDING
Adrian	I've got a smashing idea	Yes we have look...	I think we could sort them into a set of things that.....
Rhian	These toys have wheels these don't ...	I think that's a good idea.	If you push the car it goes in a straight line ...
Nicola	Yes you've got to push them. * (her only comment!)		
Laura	These toys don't move and these toys do move.		You'll never get him to stand because he's meant to roll...
Stuart	Let's try that then but what about the rolling man, he won't stand up.	You could put ones with wheels in there....	If you turn these onto their sides they roll ....
Chris	And it's got a flat top as well..		Some go in a straight line and some go round.
Victoria	what about toys that make a noise and toys that do not.		This toy doesn't move because it's got a flat bottom.

Fig. 5.2.6 : Activity Overview for 'Moving Toys'

Having considered these issues, another activity was planned particularly with Nicola in mind.

Activity B ('Make 10p'[47]) was designed as a self-supporting activity to enable the children to develop skills in an enjoyable game situation. Planning in the 'fortnightly projection' included:

- ways of using the activity to encourage all of the children to co-operate, share ideas and contribute in the discussion;
- opportunities for assessing specific criteria embodied in the design game;
- opportunities to focus on Nicola's performance with particular reference to her interaction with other children within the group.

The specific learning objectives targetted were an ability to:

- use money in the context of a practical activity ... values to 10p;
- understand and use addition and subtraction facts to 10 in a practical context;
- participate as speakers and listeners in group activity;
- describe and communicate observations and events;
- take turns;
- respect other contributions.

In order to provide opportunities for assessing these objectives, a 'Board Game' was developed (see Fig. 5.2.7). The children were seated around the board and the rules of the game were explained:

"The aim of this game is to collect enough coins to make 10p. The first to do that will be the winner. You throw the die in turns and move your counter the number of spaces indicated. If you land on a space with an amount of money, for example 2p, then you collect that money from the "bank" and place it in your purse. Remember, you need to collect 10p."

Fig. 5.2.7 : Board Game for 'Make 10p'

The following extracts are taken from one group's experience of the game. Four children, Rhian, Chris, Laura and Nicola are playing:

Rhian : Can I be red?

Rhian chooses a red counter. Nicola chooses a yellow, Chris a blue and Laura a green

Rhian : My turn ... I landed on a green oh! it's no good, I can't have any money

Chris : It's 3 ... 1,2,3

Rhian : I've passed the 1p, I'll have to go all the way round again

Nicola : 6, I've got 6 (Nicola counts out 6 moves). I've landed on 2p

Laura : She's got to take 2p now. My turn ... 4, I've got to move four times

Rhian : Oh no I've missed again

Chris : I've got a 6

Rhian : Hooray! He's got 1p

Nicola : I've landed on 5p

Teacher : Let's stop the game a moment and have a look at how much money you have in your purses

Nicola : I've got 2p and 5p

Teacher : How much is that?

Nicola : 2p and 5p (looks at her fingers) 7p

Teacher : So how much do you need to win?

Nicola : Hmmm ... 3p ... but there isn't a 3p there

Laura : Oh yes there is. 2p and 1p

Chris : I've only got 1p

Rhian : Well that's more than me

Teacher : How much more do you need to collect then Chris?

Chris : 9p, I need 9p

Laura : I haven't got anything in my purse

Rhian : Nor me

Teacher : So you still need ....

Rhian : 10p. Let's carry on

Laura : I've got six ... yes, I've landed on 5p

Rhian : I've missed again

Laura : Well Rhian, you're not having much luck are you?

The teacher allows the game to continue and rejoins the group when they are nearing the end. Rhian has finally collected some money and is getting very excited

Teacher : How much have you got Chris?

Chris : I had 6p but now I've thrown and I've got another 5p. It's too much

Teacher : What do you think Chris should do?

Rhian : I think he should put it back

Laura : He could change it for 1p's and put 1p back

Rhian : Yes, but he'll win then

Teacher : But you could have another game and perhaps you will benefit from that rule ... what do you think? Do you all agree?

Rhian : Let's have another game

Teacher : Before you do let me see your purses

Nicola : I only need 1p to win

Rhian : I need 4p to win

Teacher : How many ways can you get 4p?

Rhian : 2p and 2p

Laura : 1p and 1p and 2p

Teacher : Are there any more ways?

Chris : All 1p's. 1p and 1p and 1p and 1p

Teacher : Well done. I'll leave you now to have another game on your own

The game was repeated with Adrian, Darren, Stuart and Laura. The dialogue was very similar to that of the previous group with the children formulating their own rules and applying them to the game.

Adrian : I've got another 5p so that makes 11p, it's too much

Teacher : What are we going to do then?

Stuart : Take 1p away that would be a good rule

Adrian : Yes now I've won. That's funny and I haven't played this game before

Teacher : Let's continue to see who comes second

Laura : Oh, I've got 13p that's too much. Can I put 2p and 1p back?

Stuart : Yes that's right ... 13p take away 1p and 2p is 10p. Now let's see who wins between me and Darren

Darren : Now I've got too much. I'll have to put 1p back

Stuart carries on playing until he gets 11p. In his purse he has four 1p coins, one 2p coin and one 5p coin

Stuart : If I put 1p back I'll have 10p because ... 1p and 1p and 1p and 2p is 5p and ... 5p and 5p make 10p. Can we have another game?

Adrian : Yes, I might win again

The documented dialogue provided opportunity for

- assessment to take place;
- observations and comments to be recorded;
- future planning.

The record sheets (1 to 4) were used in a similar manner to 'Moving Toys' (see Figs. 5.2.8 and 5.2.9). In addition to these sheets a 'Learning Objective Sheet' (Fig. 5.2.10) was developed to allow attention to be focused upon:

- assessment of understanding and concepts development;
- assessment of the language used by each child;
- assessment of the overall interaction with particular reference to the collaborative skills in evidence.

The use of the record sheets provides an insight into the 'thinking' of the children and opens up opportunities to assess how the children learn and what they know. Gradually over time, a picture of each child as a speaker and listener can be built up based on information from a wide variety of contexts. Examination of the 'Learning Objectives' sheet showed that Nicola scored highly on both mathematical skills and those related to speaking and listening providing a sharp contrast to her performance in the 'Moving Toys' activity.

EVALUATION SHEET

SHEET 1

ACTIVITY	MAKE 10p
NAMES OF CHILDREN	Rhian, Laura, Chris, Nicola,
CURRICULAR AREA	Mathematics - addition / subtraction with money
APPARATUS	Game Board, play money
ORGANISATION	• children seated in a group around the table

EXAMPLE OF DIALOGUE

NICOLA : 6, I've got a 6
I've landed on a 2p

LAURA : She's got to take 2p now.
My turn ... 4 I've got to move four times.

RHIAN : Oh no! I've missed again.

CHRIS : I've got 6

RHIAN : Hooray he's got 1p.

Nicola : I've landed on 5p.

TEACHER : Let's stop the game a moment and have a look at how much money you have in your purses ....

COMMENTS

A very enjoyable activity for all of the children

- Nicola performed with more confidence in the small group procedure.
- The game situation provided Nicola with opportunity to make verbal responses in a relaxed and enjoyable manner.

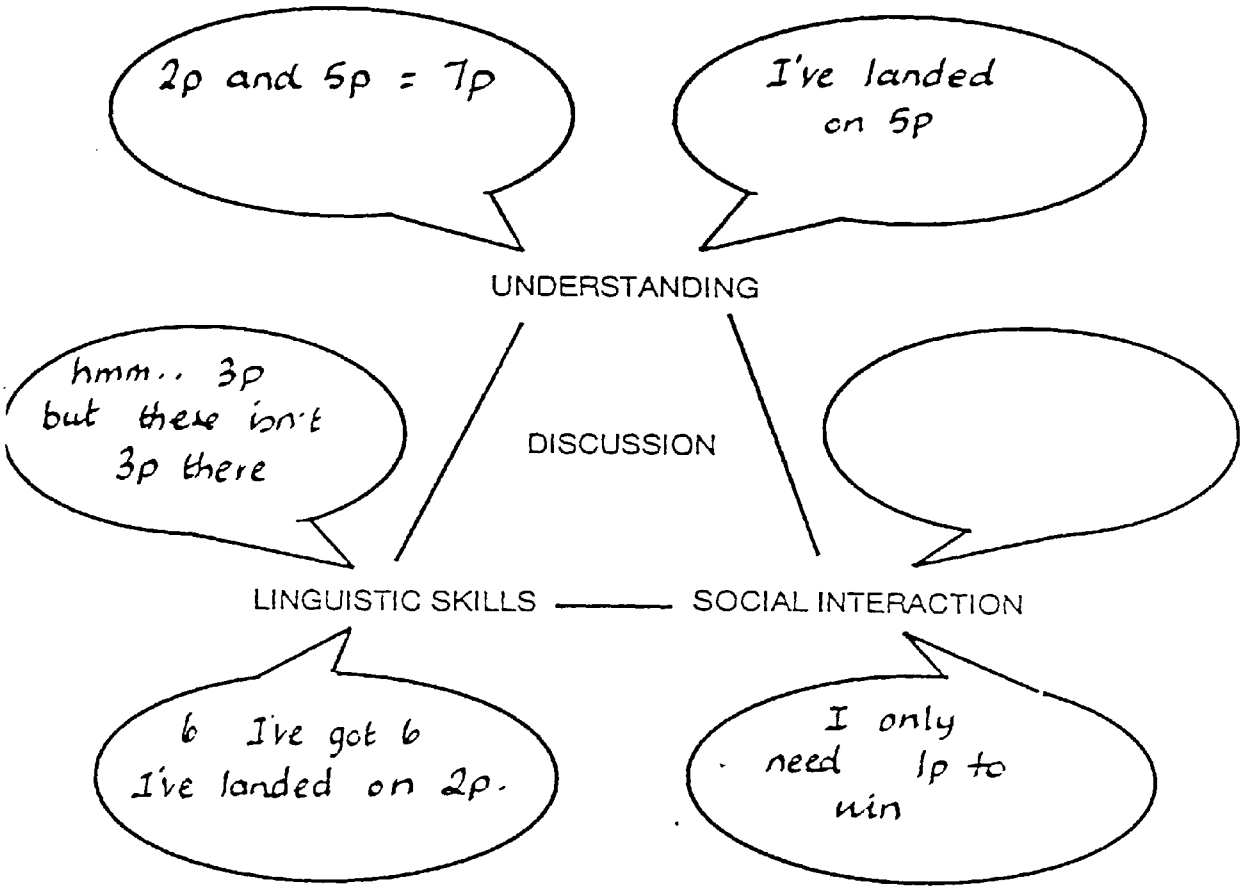
Fig. 5.2.8 : Evaluation Sheet for 'Make 10p'

SHEET 2

QUICK EVALUATION SHEET

SHOWING EXAMPLES OF INDIVIDUAL CHILD'S CONTRIBUTION TO DISCUSSION

NAME OF ACTIVITY	MAKE 10p
NAME OF CHILD	Nicola AGE 6



COMMENTS

Nicola has performed more positively in this activity. She appears to work better in a small group situation and particularly enjoys a game activity. Nicola is by nature a quiet child and is quite happy to work quietly on her own. This activity encouraged her to develop:-

(i) social skills;
(ii) to share;
(iii) communicate with her peers.

Fig. 5.2.9 : Quick Evaluation Sheet for Nicola

DESIGN OBJECTIVES **ACTIVITY: 'Make 10p'**

	Rhian	Chris	Laura	Nicola	Adrian	Darren	Stuart	Laura
Mathematics								
• ability to use money to 10p in a game situation	✓	✓	✓	✓	✓	✓	✓	✓
• understands addition to and subtraction to 10p	✓	✓	✓	✓	✓	✓	✓	✓
Linguistic & Literacy								
• participate as speakers and listeners in a group activity	✓	✓	✓	✓	✓	✓	✓	✓
• respond to instruction from teacher and colleagues	✓	✓	✓	✓	✓	✓	✓	✓
• describe and communicate observations and events								
Social Interaction								
• ability to work collaboratively with other members of group	✓	✓	✓	✓	✓	✓	✓	✓
• shows respect for others' contribution and criticism	✓	✓	✓	✓	✓	✓	✓	✓
• developing a positive attitude	✓	✓	✓	✓	✓	✓	✓	✓

Figure 5.2.10: Learning Objective Sheet

An important factor that has arisen from analysing the comments made by the children is that the quality of children's talk depends very much upon the context in which it is placed. Not every child will respond effectively in the same way. For this reason an assessment model which involves collecting information over a range of contexts and time is one that would be recommended.

Other factors which influence the conduct of the assessment can be related to the role of the teacher.

(i) Intervention by the teacher

Thoughtful and positive intervention on the part of the teacher has a significant impact in developing discussion.

Teacher	:	So how much do you need to win?
Nicola	:	I've got 2p and 5p
Teacher	:	How much is that?
Nicola	:	2p and 5p ... 7p hmm!! 3p, but there isn't 3p there

Nicola was kept involved in a sensitive manner by careful intervention, encouraging her to 'think more deeply' about what she was doing. The discussion continues with Laura providing the solution to Nicola's problem.

Laura	:	Oh yes there is. 2p and 1p

Laura's involvement is to be valued and encouraged as it shows her willingness to offer help and guidance to her colleague. Laura is made to feel confident because she has been allowed to give a 'valued' contribution, while Nicola obviously benefits as she has a solution to her problem.

(ii) Allowing time for children to think

Teacher : Before you do let me see your purses

Let's stop the game a moment and let me see how much you have in your purses

What do you think Chris should do?

This type of intervention on the teacher's part produces a number of positive outcomes:

- Each child is required to make a comment. This is of particular benefit to Nicola
- By allowing 'time' for thinking to take place both the teacher and the child have opportunity to 'reflect' on what they have been doing and use that experience to move their thinking forward.

(iii) Opening up the situation

In the following extract, the situation is 'opened up' and the children encouraged to make their own rules for the game.

Teacher : What do you think Chris should do?

Rhian : I think he should put it back

(Chris has 6p and has collected another 5p making 11p in total. If he had drawn a 4p he would have won)

Laura : He could change it for 1p's and put 1p back

(Laura offers a valid solution to the problem but meets with some resistance from Rhian who wants to win)

Rhian : Yes, but he'll win then

Teacher : But you could have another game and perhaps you will benefit from that rule ... what do you think?

Rhian : Let's have another game

(iv) Types of questions

In the above extract the children are directed by the teacher to focus their attention upon one aspect of the activity: "What do you think Chris should do?"

The fact that the children are being asked for their opinions shows that whatever they say will be valued by all concerned.

Similar comments apply to the question: "Do you all agree?"

Here the context for learning is opened up to all of the children within the group. Before carrying on with the activity the teacher seeks approval from the rest of the group and allows them time to offer their opinions. In this way a positive climate for learning is developed, one in which the children develop self esteem and become confident in expressing a point of view. Gradually this philosophy will permeate throughout the classroom. Children will develop the ability to:

- make decisions;
- become involved in their learning;
- become independent;
- use language effectively;
- develop understanding.

5.3 SUMMATIVE ASSESSMENT

Sections 5.1 and 5.2 have indicated how it is possible to:

(i) gather evidence of pupil's learning during a practical activity;
(ii) make judgements about pupil's learning;
(iii) record those judgements in a manner which provides information for future planning.

Having made judgements about each child's development and recorded supporting evidence, there comes a point at which it is necessary to make summative judgements in order to report progress, attainment and achievement to interested parties.

At the end of Key Stage 1 there is a statutory requirements for all year 2 teachers to finalise their 'teacher assessment' results prior to implementing the Standard Assessment Tasks. Teacher assessment forms the basis for deciding the levels attained in all attainment targets that are not the focus of statutory tasks. At this stage the school's recording system will contain a comprehensive set of records that give a detailed insight of the mathematical development of each child.

The Mathematics Booklet[42] referred to in Chapter 3 provides a structured programme for:

- the children to work through at their own pace
- the teacher to plan future learning
- the teacher to record progress, achievement and attainment.

However, it is important to appreciate that work carried out within one content area will undoubtedly influence and broaden children's experience of mathematics as a whole. Each experience given will interact one with another to allow children to develop a fuller understanding of the mathematics involved.

During the activity 'Moving Toys', comments and observations were recorded about Stuart and Adrian's ability to communicate at a relatively high level for their age. A record was kept of their understanding and their ability to sort the objects according to criteria they had decided for themselves. It is possible to transfer the accumulated evidence onto the school's assessment record sheet for mathematics. Fig. 5.3.1 shows the learning objectives for the 'Yellow Stage' of Shape and Space, and highlights the experiences that need to be developed before an informed judgement regarding mastery of skills can be finalised. These in turn can be used to show progress and attainment across the 'Yellow Stage' of Shape and Space.

	SI:2 EARLY SORTING OF 3/D SHAPES SI:3 EARLY SORTING OF 2/D SHAPES
1.	Child is able to sort 3/D shapes into sets of objects that look alike.
2.	Child is able to sort 3/D shapes into Those that roll .....Those that do not roll corners.....without corners solid.....hollow flat faces.....curved faces
3.	Child is able to use 3/D shapes (boxes, and containers) for 'junk modelling' - learning from experience that some shapes fit together and stack, while others will not.
4.	Knowing names of shapes (2/D) ...square, circle, hexagon, rectangle, triangle etc. child is able to sort for own criteria according to size, shape, colour, number of edges etc. (see p 113 Nuffield Handbook One)

Fig. 5.3.1 : Extract from Porth Infants Mathematics Assessment Book 'Shape and Space'

All of the children involved were able to sort the objects according to their own criteria. For a more prescriptive assessment to be made the children need experiences using 3-dimensional and 2-dimensional shapes in a variety of different contexts. Such a programme was implemented over the following weeks and a record kept of each child's ability to sort according to set criteria, e.g. shape, colour, size, thickness, with corners, straight edges, curved edges, etc. In this way a complete picture is produced of the child's development in 'Shape and Space'.

For convenience the Mathematics Assessment Sheet (see Fig. 3.5.1) is completed three times a year as a preliminary to each of the parental conferences the school holds. In terms of National Curriculum Orders, these children are working at:

AT 3 Shape and Space

Level	Programme of Study	Example
3	Sorting 2-D and 3-D shapes and give reasons for each method of sorting	Sort shapes with square corners and curved edges etc., giving appropriate explanation

and

AT 5 Handling Data

Level	Programme of Study
1	Selecting criteria for sorting a set of objects and applying them consistently

The records of the children's work during Activity B show that they are all working at the green and orange stage in the 'Money' section of the School's Mathematics Assessment booklet[42].

M1-2

Step 5: Child is able to make amounts to 10p; and

M-4 Early stages in Shopping

Step 1: Child is able to use simple shopping activities in play situations using money in buying and selling activities.

Step 2 : Child is able to deduce how much money has been spent.

In National Curriculum terms these children have achieved part of AT 3/Level 2 (Know and use addition and subtraction up to 10). To achieve all of Level 2 the teacher will need to plan further work on

- solving problems involving addition and subtraction, including money (to value 20p);
- comparing two numbers to find the difference;
- understanding the meaning of 'half' and 'quarter';
- using non standard measures in length, area, capacity, 'weight' and time; comparing objects and events and recognising the need for standard units;
- learning and using the language for common units in length, capacity, 'weight', and time.

The systematic records of children's learning provide evidence of progress through a differentiated programme of work suited to the needs of each child. Assessment information can be summarised at any time to determine progress. At the end of Key Stage 1 the final level decided by the

teacher should broadly reflect attainment across the statements at that level. Such a 'Summative Record' can be used for a variety of reporting purposes and audiences.

CHAPTER 6

CLASSROOM MANAGEMENT IN ACTION

6.1 STRATEGIES FOR DEVELOPING EFFECTIVE MANAGEMENT

Effective classroom management which supports a 'discussion based approach' to teaching will include the development of a number of skills both for the teacher and for the children involved.

Teachers need to:

- plan effective situations that encourage children to take part in their learning;
- organise the classroom to support children;
- carry out 'discussion activities' while at the same time **manage** the rest of the class;
- engage in a 'whole school' approach to co-ordinate this initiative throughout the school so that there is consistency of teaching and learning.

One of the biggest concerns for teachers involved in classroom management is that while working with a group of children the rest of the class should be involved in a valid and profitable manner.

Careful planning and perhaps more time being spent on activities for the rest of the class will ensure that the work presented to all of the children will be challenging and well matched to their abilities.

This research has recognised the important aspects of a discussion based approach as allowing children to develop skills in sharing ideas, talking about their work and helping each other. Through this approach children will also develop an attitude that reflects a degree of responsibility for each other and for their learning. Evidence of this is demonstrated in the Activity **Make 10p** described in Chapter 5, page 118. Here Laura asks for advice by saying

> "Can I put 2p and 1p back?"
>
> Stuart replies with confidence
>
> "Yes that's right .... 13p take away 1p and 2p is 10p. Now let's see who wins between me and Darren.

This short extract shows how children can, if given the opportunity, take responsibility for the development of their learning. Stuart takes on the role of the teacher offering Laura guidance in a supportive and encouraging manner.

To address these issues and to offer support and guidance to teachers wishing to implement this approach, a number of strategies have been developed:

Strategy 1. Structure mathematical activity with the aim of releasing the teacher

Incorporated into many of the discussion activities is a set period where the children work at some form of recording. The strategy can be used to provide opportunities for formative assessment by allowing the teacher to observe and record the interaction of the group as they work on a particular activity. This strategy supports effective classroom organisation and can also be used to release the teacher to manage the rest of the children working in other areas of the classroom. Fig. 6.1.1 shows this strategy in the form of a flow chart.

In the following extract, taken from 'Activity C, Patterns'[48], the teacher leaves the group on two occasions. The children were each given sorting trays and a variety of two-dimensional coloured shapes. The activity was initiated by the teacher asking the group to make a symmetrical pattern with the shapes.

Teacher: "I want you to make a symmetrical pattern with these shapes and when I come back I want you to talk about what you have done".

By asking the children to be prepared to talk about their patterns the teacher is focusing their attention on the activity with a particular outcome in mind.

The teacher now leaves this group to see other children within the class and on returning to the group the following discussion ensued:

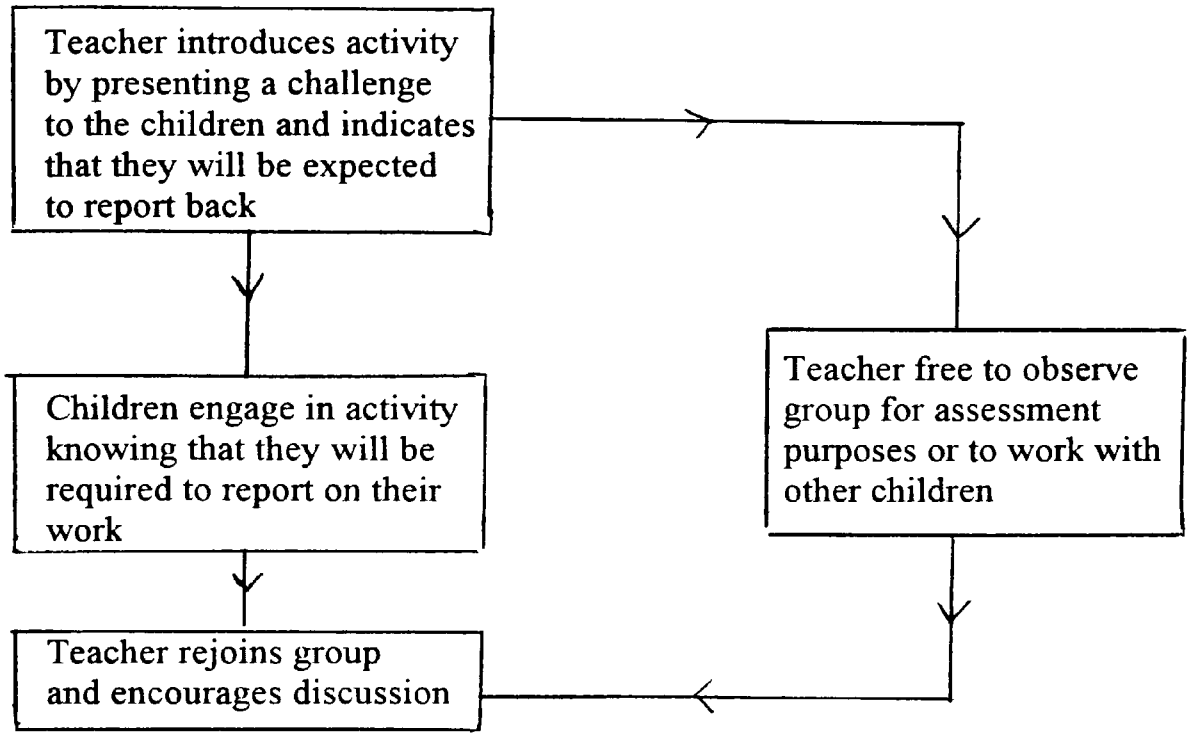


Figure 6.1.1: Flowchart for Strategy 1

Structure mathematical activity with the aim of releasing the teacher

Stuart: I've used the most shapes

Darren: I made a crab shape, it looks like a dog as well.

Teacher: What shapes did you use?

Darren: Triangles, diamonds, some blue, some green.

Adrian: Darren, you used a square for the tail.

Darren: No, it's a diamond, look.

Adrian: It's not the right way to be a square.

(Darren has used a square and turned it on its end to look like a diamond)

Stuart: It is a square Adrian, look at it this way.

Stuart picks up the square and turns it around.

Adrian: Yes, O.K.

Rhian: Go on Victoria, tell us about yours.

The discussion continues with each child giving an account of what they have done. The children were then asked to design a 'cluster' of shapes that could be used to make a ring. They were asked to check their patterns, with a mirror, to see if they were symmetrical, and then to draw their results onto paper so that they could be displayed in a book in the 'Classroom Jewellery Shop'.

Having presented the children with the challenge, the teacher was able to remain with the group to assess, through observation, each child's ability to:

i) tessellate the shapes;

ii) understand symmetry, reflections;

iii) to record findings;

iv) interact with other group members;

v) use discussion skills.

Strategy 2: Clarify the management of the activity so that the children understand what is expected of them

This strategy was found to be of particular use when playing a game as it helped to avoid confusion and gave the group a shared purpose. Since mathematical activity has much in common with game situations in which children are constrained by set rules, this strategy is useful in all mathematical situations to clarify the situation and thus avoided confusion.

Initially an activity is discussed with the children and each child is required to contribute. This enables each child to become active in the learning process from the beginning. Learning becomes a two-way shared process between the teacher and the group of children, and a climate is established whereby the children are encouraged to negotiate meaning. Figure 6.1.3 shows this strategy in the form of a flowchart.

Activity D[49] shows how this strategy has been successfully incorporated into a session. The game is played with two players, a set of cards numbered 2, 3, 4, 5, 6, 7, 8, 9, 10, and 2 dice. The cards are arranged as shown in Fig. 6.1.2.

2	3	4
5	6	7
8	9	10

Figure 6.1.2: Dice Game Activity

Each child is required to throw the dice and add up the score. The card with the answer on is turned over, e.g. 2 + 3 = 5, therefore 5 is turned face down.

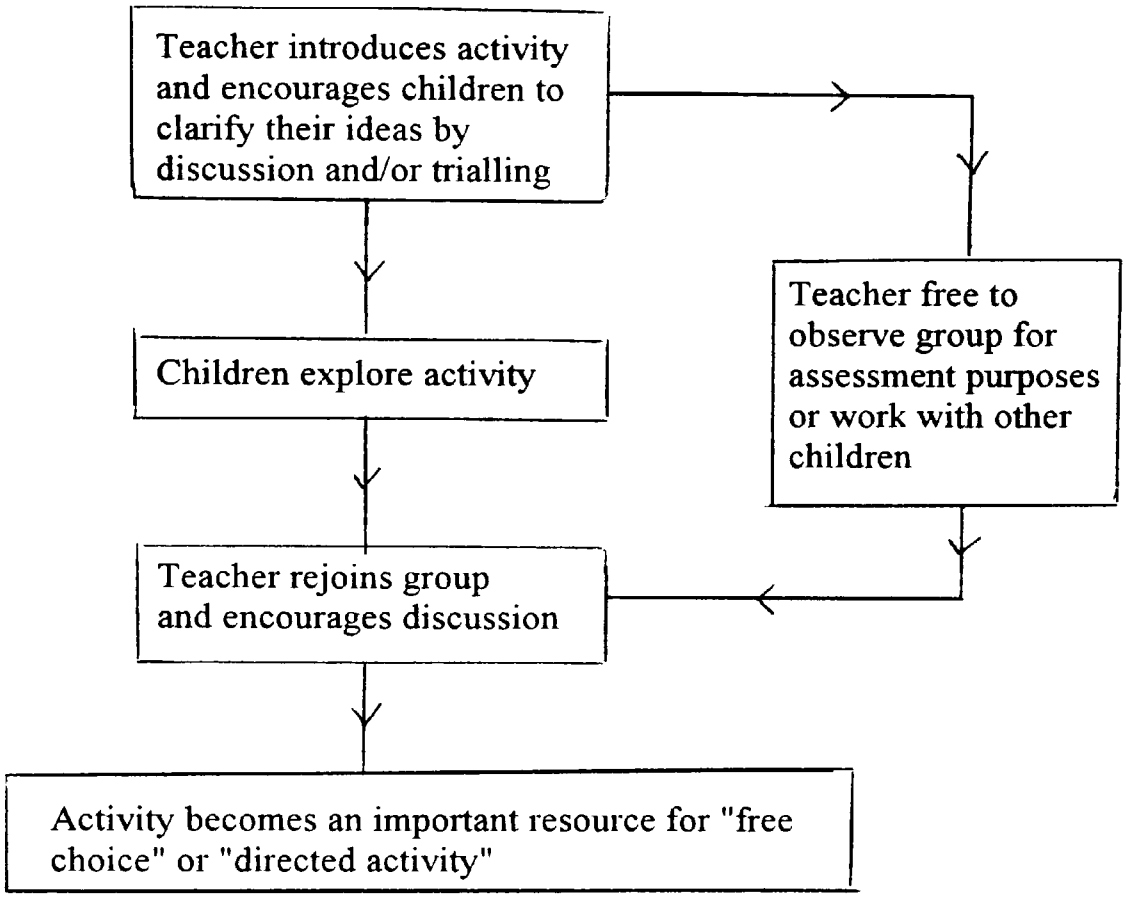


Figure 6.1.3: Flowchart for Strategy 2

Ensure that children are clear concerning what is expected of them

The first child to complete a line horizontally, diagonally or vertically, will score 1 point. The winner will be the first child to score 5 points.

Teacher: Let's watch Stuart and Victoria playing the game.

Stuart: 2 and 3 that's 5.

Adrian: I can see where that is.

Darren: He's won he has five points.

Adrian: No, it's 1 point for each set of three and you've got to reach 5 points to win.

Victoria: I've got 9, 4 and 5.

This extract shows how two children play the game while other children interact to develop understanding and negotiate meaning. Adrian clarifies the point for Darren but in so doing helps the other children by explaining the rule in a clear succinct manner. Further on in the activity the teacher intervenes to assess the children's understanding of the game.

Teacher: How are you going to carry on with the game? Do you want to start all over again?

This intervention enables the teacher to ensure that the game is proceeding without any problems and that each child has an opportunity to ask questions.

Having played one game the children were able to continue on their own and the game became an important resource in the classroom. As a self-supporting activity it releases the teacher to observe and record for assessment purposes or to work with other children in other curriculum areas. It also has

the potential for use in Free Choice Activities where children often work without the attention of an adult.

Strategy 3: Encourage children to contribute in discussion work and to emphasise that their contributions are valued

The quality of the 'talk' in the discussion will depend upon the ability of each child to interact within the group. Young children are dependent on adults as role models and often imitate the actions of the teacher. If the teacher demonstrates that the viewpoints of others are valued and taken into account, then children will come to recognise this and put the same methods into practice themselves.

The following activity (Calculator Houses, Activity E)[50] shows how this strategy is used to enhance the quality of the interaction. The teacher explains the rules to the group and uses Strategy 2 to allow children to familiarise themselves with the activity. The game was originally designed for two players and requires base boards similar to Fig. 6.1.4.

Equipment Required

2 base boards

coloured window, door and chimney pieces

calculator

Activity

- Group members decide on a target number (say 5)
- Players try to make five
- Players take turns to choose a house part, e.g. a window, which has a number associated with it, enter the chosen number into the calculator

and then perform one operation to change this number to 5 (e.g. 12-7 = 5).

- If correct, the house part is covered with a 'coloured piece'.

The game involves addition and subtraction of numbers from 1 to 20. The initial target is decided by placing one of the cloud cards over the smoke from the chimney.

The children take turns to make a number statement that will change the chosen number to make the number in the smoke. Any correct statement is acceptable. The first child to complete the house is the winner. We join the discussion with Adrian and Stuart talking about what they have been doing.

Teacher: Stuart, you can go first. Tell us what you have got to do?

Adrian: 9 add 1 to make 10.

Stuart: Yes, he's right, no need to check it on the calculator.

Adrian: Your turn.

Stuart: I'm going to choose a roof - I need 1 to make 4 from 3.

Adrian: 6 add 4 to make a door.

Stuart: No, it's ..... are you allowed to do take aways?

Teacher: What do you think?

Stuart: Yes, 6 take away 2 equals 4, and 3 add 1 equals 4.

Teacher: Well done Stuart. Do you all understand the game?

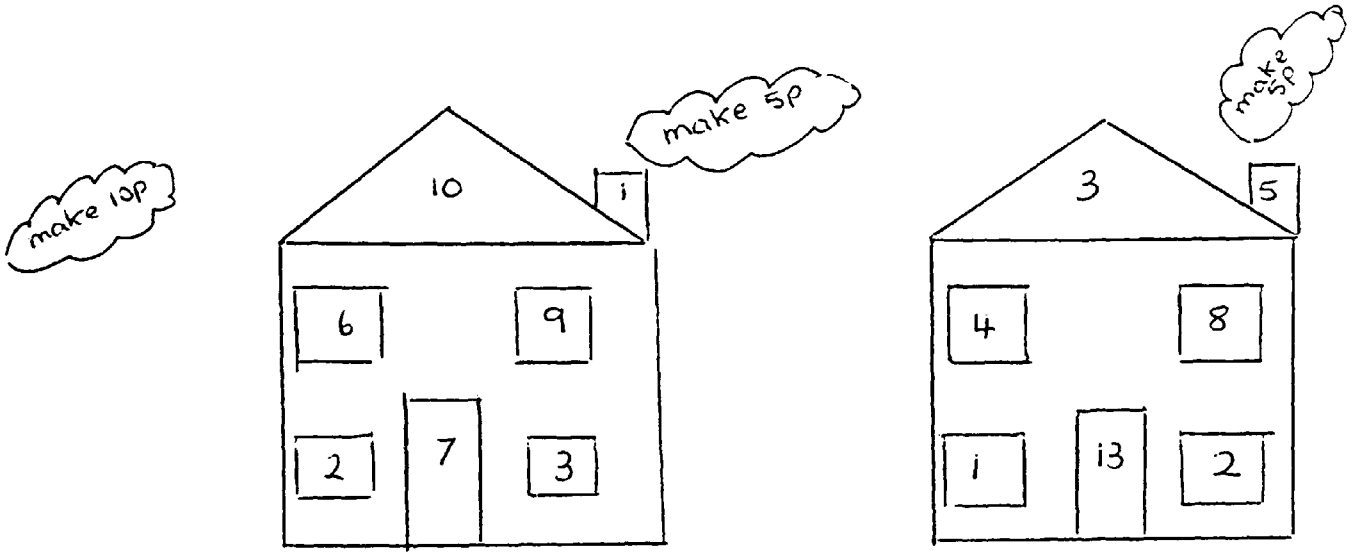


Fig. 6.1.4: Activity Boards

The teacher directs Stuart to tell the group what he needs to do (Strategy 2 into action). Immediately Stuart feels valued because he has been asked to give his opinion. Throughout the activity the teacher encourages the children to enter into discussion by asking:

i) what do you think?

ii) do you all agree?

This action serves to promote self esteem and the development of a positive approach to learning. Encouraging children in this way will reveal itself in future learning experiences and enhance the quality of teaching. Fig. 6.1.5 shows this strategy in the form of a flowchart.

As an extension activity the above group were given blank houses and asked to enter their own numbers (see Fig. 6.1.6 for Rhian's sheet).

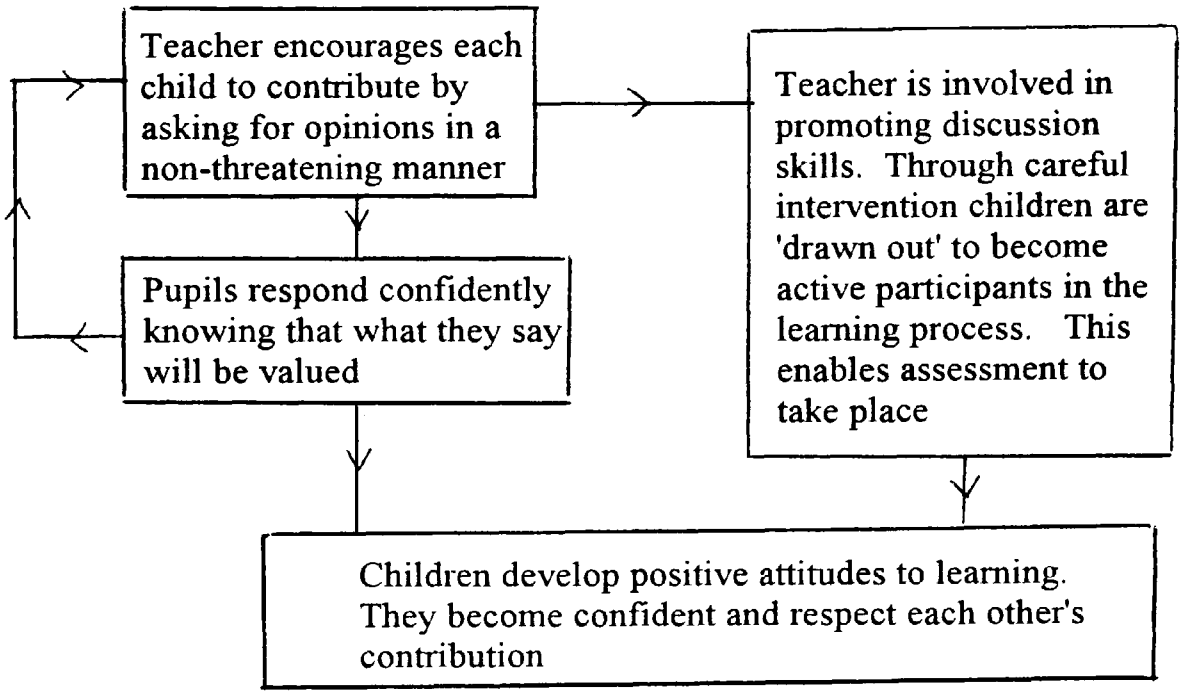


Figure 6.1.5: Flowchart for Strategy 3

Encourage children to contribute in discussion work and emphasise that their contributions are valued

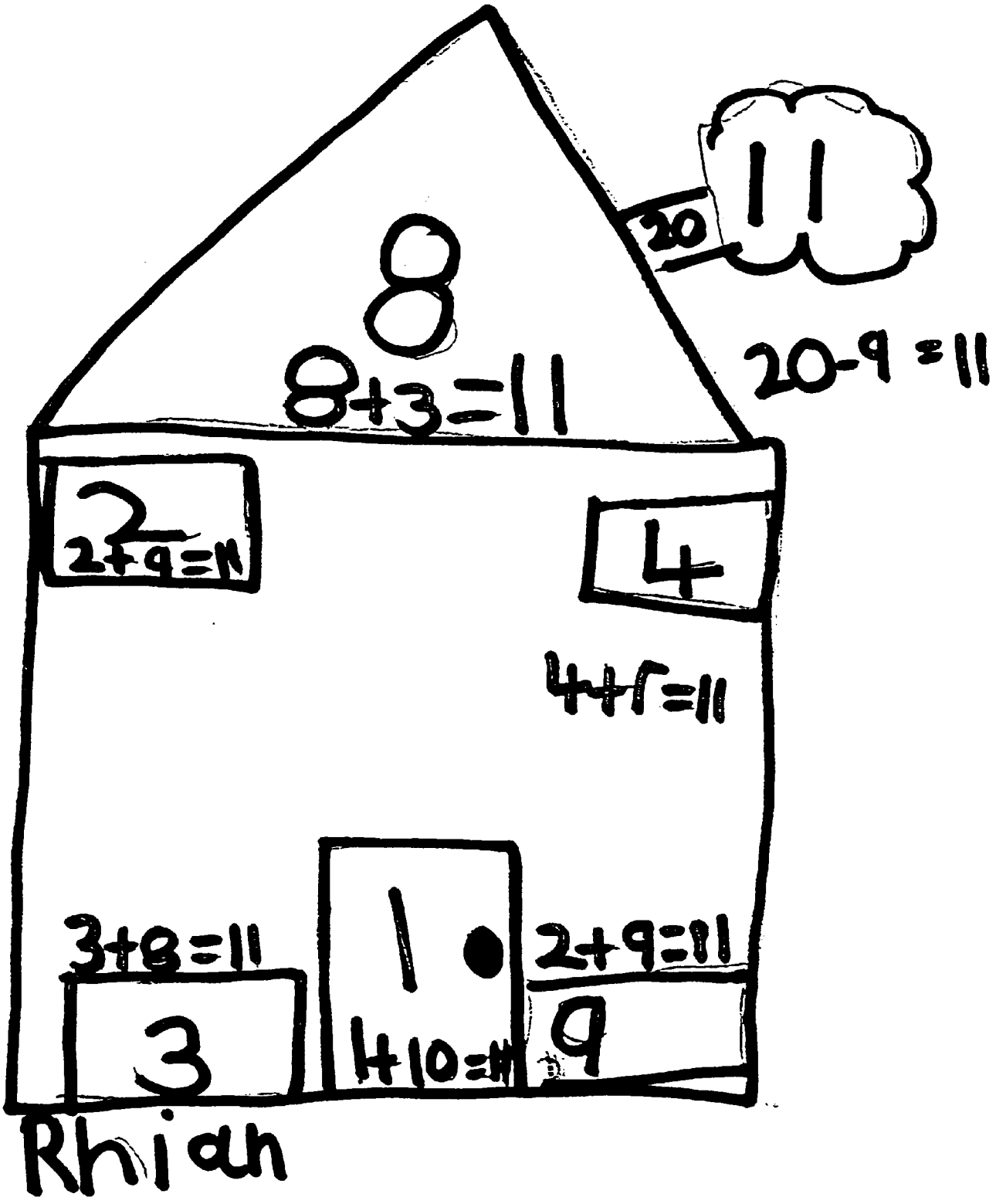


Figure 6.1.6: Extension activity, Rhian's sheet

Incorporating recording procedures into the activity allows the teacher to put Strategy 1 into action.

Strategy 4:	**Intervene with quality questions of an open-ended nature to: (i) develop mathematical thinking; (ii) encourage children to ask their own questions; (iii) assess understanding**

From this research it has become apparent that the role of the teacher includes a number of functions. It is necessary for the teacher to be aware of these functions so that skills can be applied to the best advantage.

Self-evaluation of performance by the teacher serves to promote professional development. It allows the teacher to analyse her role and judge the effectiveness of her teaching through the responses from the children.

The following extract from Activity F 'Rainy Days'[51] illustrates how a specific type of questioning can:

- draw out responses from the children;
- improve the quality of talk;
- encourage children to ask questions themselves.

The Rainy Days Activity was planned to give children opportunity to apply their skills in finding ways of recording their results through handling data. The activity was carried out in the Science Corner, and the children

were given the challenge to investigate which material they would like to use to make a hat to keep them dry.

Teacher: Which do you think would be the best for a hat?
Question

Pupil response:
Adrian: We could make all sorts of hats and when it's raining we could all wear different hats and go out in the rain and see which is the best.

Victoria: When it's a dry day we could pour water over them. If it goes through we can tell it's no good.

Teacher -
Encouraging: Well, there are two good suggestions. Can anyone think of any more?

Question: How can we test the materials in the classroom?

Throughout the activity the teacher's approach encourages the children to respond and contribute to the discussion with constructive, quality responses, e.g.

"I think this one, it's got a sort of cold feeling and its smooth so the rain will fall off".

Reflecting on the discussion will allow the teacher opportunity to focus specifically on:

i) the type of questions that the teacher presents to the group (Fig. 6.1.8)

ii) the pupil responses (Fig. 6.1.9)

'Rainy Days'

Teacher Intervention

- Well, there are two good suggestions.
- Can anyone think of any more?
- Why do you think that is the best?
- How can we test the materials in the classroom?
- How can we record these on paper?
- How does it feel?
- Do you know what that material is called?
- Well, have you all made your choice?
- Can you think of a way we can test these materials?
- What do you think would be the best material for a rain hat?

Fig. 6.1.8: Teacher Interventions

Pupil Response

Some examples of pupil responses from Rainy Days

- We could make all sorts of hats and when its raining we could all wear different hats and go out in the rain.
- Get something flat and pour water over it, you won't have to go out then.
- You could put them in a tub of water so they get wet **which shall we use**?
- I think this material, its got flowers on it and I like it.
- I think the leatherette as well because it's thicker and water will go through the paper.
- Yes, that's a good idea.
- I've got an idea you, you could tie them.
- Try paper first, yes, let's try the crepe paper, its got to go through the one.
- Why isn't it going through?
- Yes, you've got to wait for a long time for it to go through, its all soggy now - look at the newspaper that's soggy too.
- I wonder what will happen?

Fig. 6.1.9: Pupil Responses from Rainy Days

Notice that the teacher's approach encourages the children to ask questions themselves, e.g.

- Which shall we use?
- Why isn't it going through?
- I wonder what will happen?

Questions of the type in Fig. 6.1.10 serve to encourage children to develop their own thinking while learning from the experiences of their peer group.

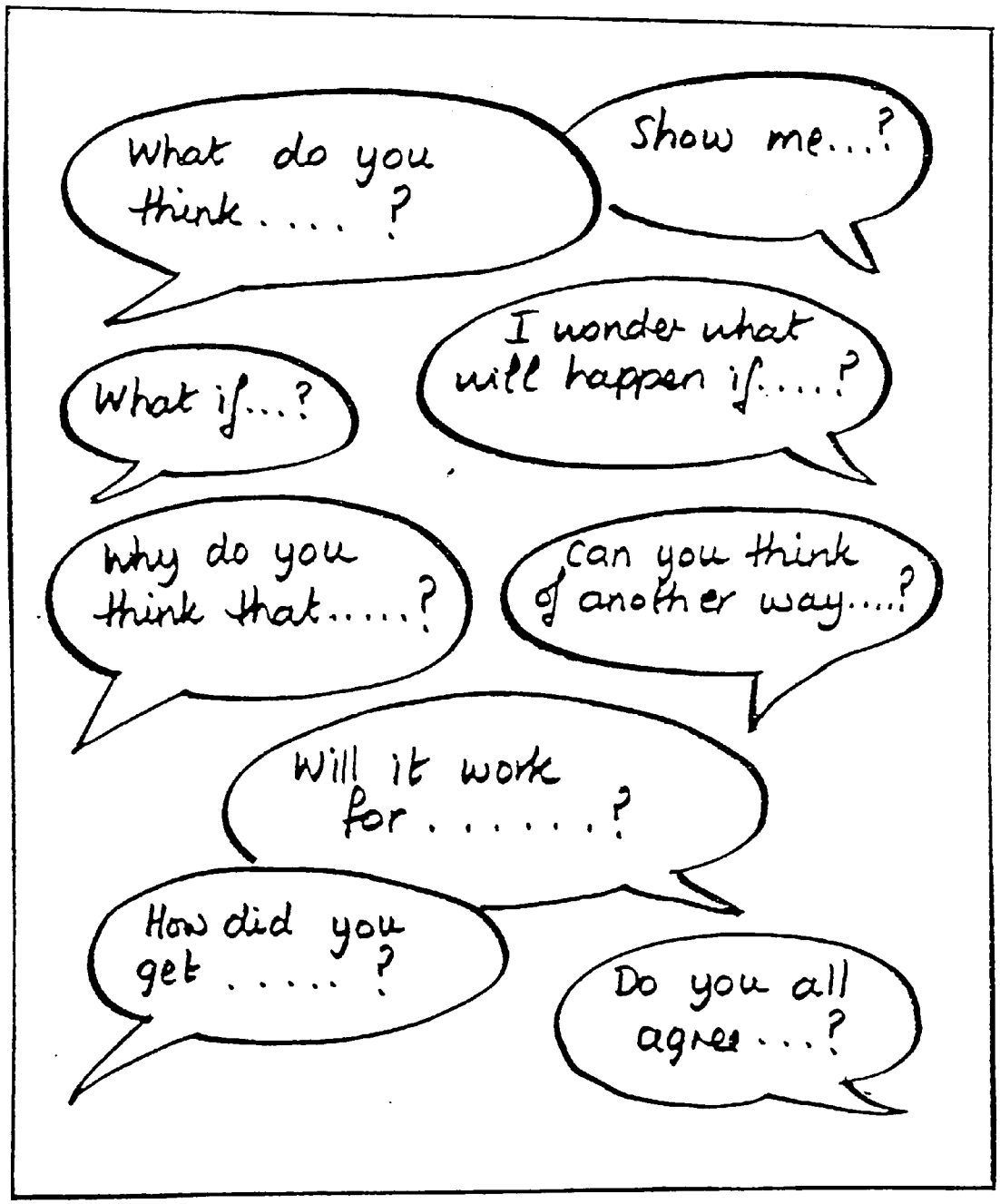


Fig. 6.1.10: Questions to promote mathematical thinking

The children's linguistic skills will also improve as they are required to use their skills in speaking and listening and to apply them to the activity to communicate meaning.

Activity G 'Food for Thought'[52] is an ideal example of how, through sensitive intervention, the quality of the thinking of the children is extended.

The children were asked to find out what sort of food was available in the school dining room. A visit was made and the children recorded the different meals over a period of a week. They used a variety of methods for recording their results and these were displayed in the classroom. Their findings included the most popular choices made by the children, being beefburgers, sausages, chips, boiled potatoes, beans and peas. The teacher asked the children to find out how many different meals could be served from:

beefburgers or sausages

chips or boiled potatoes

peas or beans

In order to help the children to carry out the investigation the teacher gave them a recipe for play dough. This provided the group with the opportunity to visit the local shop, buy ingredients, and develop skills in measurement.

The following extract is taken from the activity. The children are clarifying their thoughts and negotiating which method to use:

Teacher: This recipe for playdough requires the same amount of flour as salt. How can we measure that?

Stuart: You could put 1 weight on one side of the scales and put flour on the other side until it balances. Then take out the flour and put salt in until it balances.

Victoria: Yes ... you could do that but I would put one lot in one side and the other lot in the other side until it balances. You don't need weights.

Teacher: What do you think Adrian?

Adrian: Yes, flour in one side and salt in the other, when it balances you could take one out and use a weight then you'll know how much you need without weighing them both.

Teacher: Well, which method shall we use?

Laura: Balancing both.

Teacher: Do you all agree?

Stuart: Well yes, Adrian's method has a bit of mine and Victoria's in it anyway.

The children continue with the activity and reach the stage where they have balanced the salt with the flour. They have a variety of weights in front of them, 250 gm, 100 gm, 100 gm, 100 gm, 20 gm, 10 gm. The teacher guides the children onto the next step by asking:

Teacher: How heavy is the flour?

Darren: 250 and 100 is 350, 350 and 450 ... 550, 570 ... 580

Stuart: I make it 570

Teacher: Stuart, would you like to check again.

Stuart: Yes, you are right Darren, 580.

Teacher: What do you think Rhian?

Rhian: We could use a calculator.

Stuart: I can think of another way. You could add the hundreds first. 3 hundreds and 2 hundreds, 5 hundreds.

Teacher: I can see the 3 hundred weights. Where did you get the 2 hundreds from.

Stuart: From the 250, so that's 500 plus 50 from the 250, that's 550 and 20 and 10 equals 580.

Girls using calculator:

Rhian: We've 580 with the calculator so Darren was right.

The children then proceeded to make play dough by adding water. This in itself was a worthwhile activity and enriched the children's language through experience. They looked at the changes in the substances and what happened when the dough was rolled out, shaped and cooked. The final result was play dough food in the form of beefburgers, sausages, peas, beans, potatoes and chips. The materials would be used in the next session to investigate ways of making dinners.

From the extract above the teacher intervention is carefully planned to:

i) encourage the children to think "How can we measure that?"

ii) improve quality of pupil response, e.g. "You could put 1 weight on one side of the scales and put flour on the other side until it balances ..."

iii) encourage children to learn from each other and share ideas: "Well yes, Adrian's method has a bit of mine and Victoria's in it anyway".

Further on in the activity the children are again encouraged to develop their thinking.

Teacher: "How heavy is the flour?"

Darren: "250 and 100 is 350, 350, 450 ... 550 ... 570 ... 580"

Stuart: "I can think of another way .... You could add up the hundreds first".

Fig. 6.1.11 shows how Strategy 4 is applied to develop mathematical thinking and encourages children to negotiate meaning from what they are doing. The model indicates the ongoing effect on learning as positive attitudes are gradually built up and reinforced.

6.2 STRATEGIES IN ACTION (CASE STUDY)

The following case study has been chosen to illustrate the use of all four strategies described in Section 6.1.

The activity 'Pictures and Words' originated from the need to develop and improve the children's descriptive mathematical vocabulary. The stimulus for the session was provided by a series of published photographs 'Talking Maths Photographs' by Sheila Gallagher[53]. Fig. 6.2.1 shows an example of one of the cards with the guidance provided by the author.

The activity which is transcribed from three separate sessions shows how:

- the teacher opens up the situation to encourage discussion;
- the teacher intervention enhances the quality of learning experience;
- the children are encouraged to become active participants in the learning process;

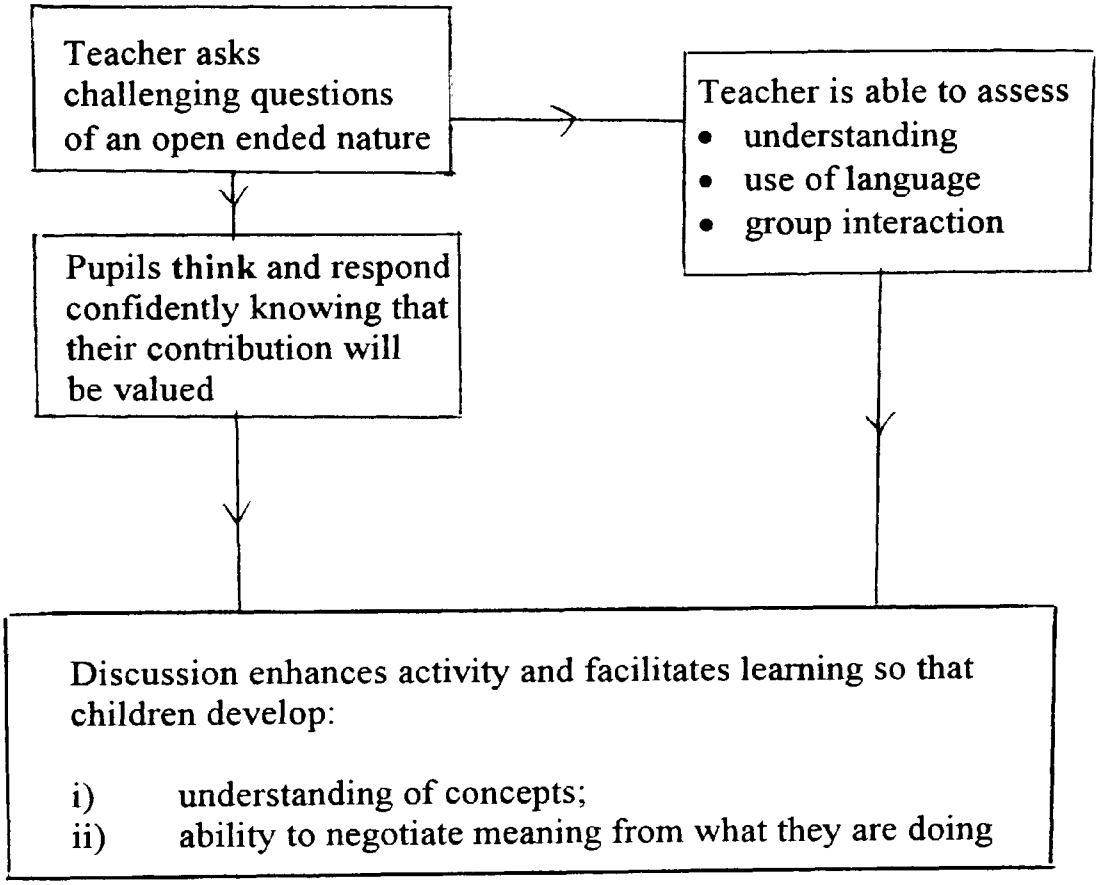
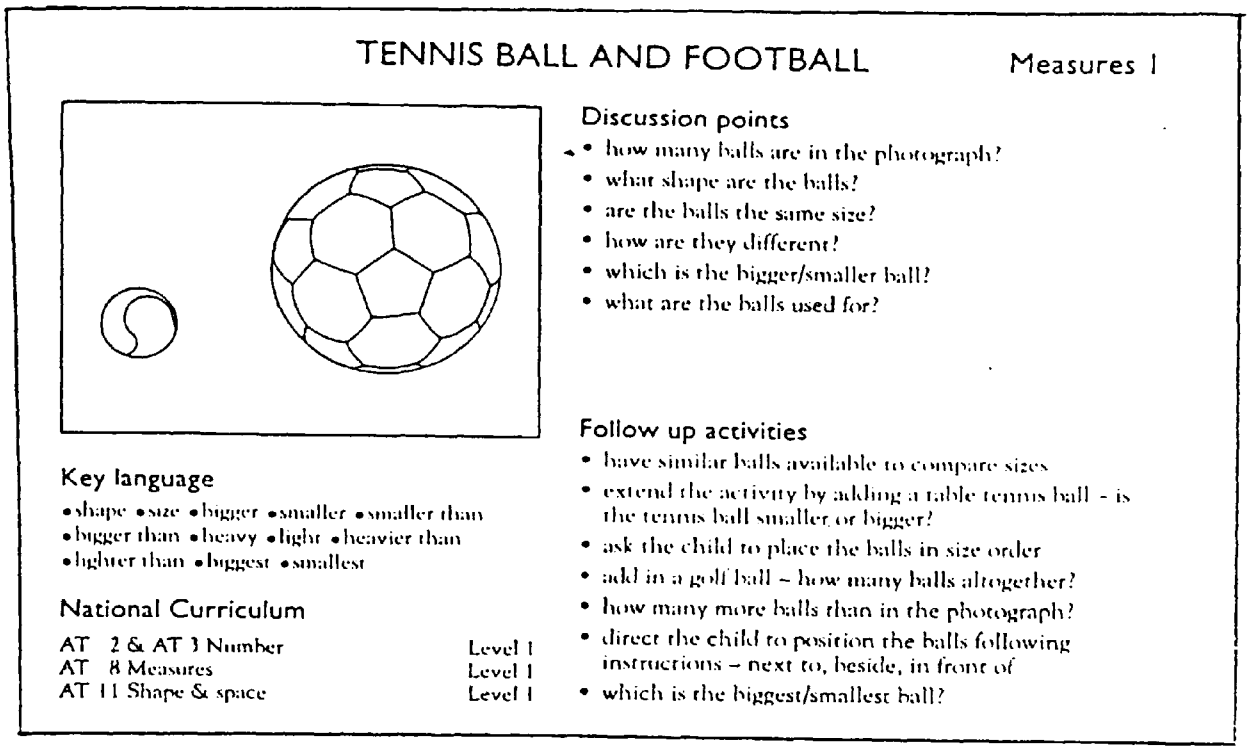


Figure 6.1.11: Flowchart for Strategy 4

Intervene with quality questions of an open-ended nature



TENNIS BALL AND FOOTBALL Measures 1

Discussion points

- how many balls are in the photograph?
- what shape are the balls?
- are the balls the same size?
- how are they different?
- which is the bigger/smaller ball?
- what are the balls used for?

Key language

•shape •size •bigger •smaller •smaller than
•bigger than •heavy •light •heavier than
•lighter than •biggest •smallest

National Curriculum

AT 2 & AT 3 Number	Level 1
AT 8 Measures	Level 1
AT 11 Shape & space	Level 1

Follow up activities

- have similar balls available to compare sizes
- extend the activity by adding a table tennis ball - is the tennis ball smaller or bigger?
- ask the child to place the balls in size order
- add in a golf ball – how many balls altogether?
- how many more balls than in the photograph?
- direct the child to position the balls following instructions – next to, beside, in front of
- which is the biggest/smallest ball?

Figure 6.2.1: Example of Work Card from 'Talking Maths Photographs'

- the teacher extends the learning process by encouraging the children to develop their thinking through discussion.

At the beginning of session one the teacher is working with two children and is following the guidance provided on a card similar to the one illustrated.

Dialogue:

Teacher:	How many children can you see?
Daniel:	Two.
Teacher:	Can you point to the tallest?
Joanna:	Well yes, she is.
Daniel:	Can we choose our own picture?

At this stage it was clear that very little discussion was going to ensue. The type of questions were 'closed' inviting a specific response and allowing very little interaction with the other children. It was decided to allow Daniel to take the lead.

Teacher:	Yes Daniel, that's a very good idea.
Laura:	Pass the cards up. I want to have a look at them.
Daniel:	I'm not fussy on any of these ones. Let me see your pile. Oh! Look at this one.
Teacher:	Everyone look at Daniel's card. What can you tell us about your card Daniel?
Daniel:	I've got a football and a cricket ball, one big and one small.
Zoe:	Yes, and the football has blue hexagons on it.
Daniel:	They're both round.

Teacher: Can you see anything else in the classroom that is round?

Laura: Our biscuit tin.

Priya: What about sellotape? That's round. It's round on the outside and round on the inside like a polo mint.

The rest of the session continued in a similar manner with each child describing the card that they had chosen. I decided to join four of the children and get them to concentrate on one particular card.

Session 1, although initially disappointing, highlighted the importance of:

i) the role of the teacher;

ii) the need to encourage the children to develop an enquiry-based approach to learning.

By comparing the input of the teacher at the beginning and the end of the session it is possible to discern a sharp contrast in the pupil responses.

Teacher Intervention	**Pupil Response**
How many children can you see? Can you point to the tallest?	Two Well yes, she is.

Both questions, because of their 'closed' nature, invite a limited response from the children. It soon becomes apparent that the approach recommended by the scheme does not encourage interaction between the children.

The quality of the session quickly improves once the teacher allows Daniel to take the lead.

Teacher intervention	Pupil response
Yes Daniel, that's a very good idea	I'm not fussy on any of these, let me see your pile. Oh! look at this one.
Everyone look at Daniel's card. What can you tell us about your card Daniel?	I've got a football and a cricket ball, one big and one small.
	Yes and the football has blue hexagons on it.
	They're both round.

Session 2 was planned with specific outcomes in mind. The card used as a stimulus for discussion shows six dice (see Fig. 6.2.2). The dice are in three different colours and provide opportunities for:

- developing an understanding of pattern in number;
- developing an early awareness of the early principles of probability;
- developing discussion skills through group interaction.

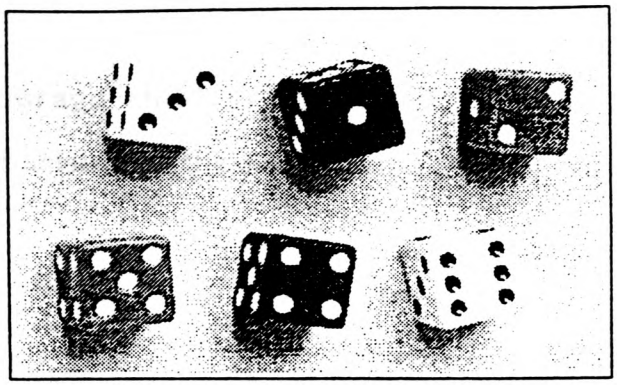


Fig. 6.2.2: Dice

Different coloured dice were available for the children to use.

Strategy 2: Clarify the management of the activity so that the children understand what is expected of them.

Teacher:	Let's all look at the card; what can you tell me about it?
Daniel:	They're different coloured dice, red, white and green.
Daniel:	They've got all of the numbers showing. There's 3,1,2,5,4,6.
Laura:	They're not in the right order. It should be 1,2,3,4,5,6.
Zoe:	Well, that doesn't matter, does it?
Daniel:	Well I think the 2 should go before the 3, then the 4 could come after, and then 5 and then 6.

The teacher intervenes to allow Jason time to contribute to the discussion. This intervention is crucial as it enables **all** children to contribute and become working members of the group. Jason's response opens-up an interesting mathematical aspect in the discussion and certainly develops his self-esteem.

Strategy 3: Encourage children to contribute in discussion work and emphasise that their contributions are valued.

Teacher:	What do you think Jason?
Jason:	My daddy told me a secret - the top and bottom numbers will always add up to 7.
Daniel:	Will they?
Laura:	Yes, look. 4 and 3. That makes 7.

Strategy 3 is applied successfully and the teacher takes the opportunity to extend the children's thinking based on what Jason has said by applying Strategy 4.

Strategy 4: To intervene with quality questions of an open ended nature to (i) develop mathematical thinking; (ii) encourage children to ask their own questions; (ii) to assess understanding.

Teacher:	Can you think of another 2 numbers that add up to 7?
Jason:	Have a look at the dice.
Laura:	There's lots of ways. 1 and 6, 3 and 4, 2 and 5, 5 and 2.
Teacher:	Look at the card. What number do you think is on the bottom of the dice?
Daniel:	If the four is on the top, then there must be a 3 on the bottom. I'm going to try that out on my mother when I go home.
Teacher:	How many ways can we make 7 from two numbers on a dice?
Zoe:	We need to write them down.

Laura: Here's some paper. I like doing these. It's like doing sums, but we've made them up ourselves.

The teacher has also applied Strategy 1 and is confident that the children understand what is required of them. The challenge allows the teacher to be released from the group and enables assessment to be made of:

- the group interaction;
- the development of discussion skills;
- the understanding of concepts.

The children worked for ten minutes and decided there were six ways of making seven. Jason said that there would be more ways if there was a nought on the dice.

Teacher: Would you like to play a game with two dice? Two of you can record and two of you can throw the dice in turns. I'd like you to throw the dice twenty times and add up the scores.

Daniel: Right, I'll throw first.

The children then spent fifteen minutes throwing the two dice and adding up the scores. They kept a record.

Teacher: Have a look at your scores; can you tell me which answer is the most popular?

Jason: We had 7 lots of times.

Laura. And 4.

Session 2 exemplifies how specific teacher interventions can produce thoughtful responses from children. These are summarised in Fig. 6.2.3.

Teacher intervention	Pupil Response
Let's all look at the card. What can you tell me about it?	They're different coloured dice, red, white and green. They've got all of the numbers showing. There's 3,1,2,5,4,6.
What do you think Jason?	My daddy told me a secret - the top and bottom numbers will always add up to 7.
Will they?	Yes, look, 4 and 3. That makes 7.
Can you think of another two numbers that add up to 7?	Have a look at the dice. There's lots of ways. 1+6, 3+4, 2+5, 5+2.
How many ways can we make 7 from two numbers on a dice?	We need to write them down. Here's some paper. I like doing these. It's like doing sums, but we've made them up ourselves.

Figure 6.2.3: Promoting thoughtful responses

Session 3 was planned to develop skills in recording and interpreting data. The children were encouraged to consider the various totals that might occur when rolling two dice.

Teacher: How can we record this information so that we can easily see how many times we had 7 as an answer, or how many times we had 6 as an answer?

Daniel: You could just count them.

Teacher: But that will take a long time. Think about all of the possible answers that we could get. What would be the highest answer?

Laura:	It's always best to get a double six in a game.
Jason:	Nothing will be the lowest score.
Daniel:	You can't get nothing with the dice because 0 isn't on it. You can get 2 with a 1 and a 1.
Teacher:	So write down 2 as your first number. What is the next one you could get?
Zoe:	You could get 3 with a 2 and a 1.
Laura:	Then 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 ...
Teacher:	Laura, didn't you say the highest score was a double six - what will that add up to?
Daniel:	Use the calculator.
Zoe:	It's 12. If we put those numbers along the top we can put ticks at the bottom.

The children write the numbers at the top and tick the numbers of ways that they got those numbers.

Laura:	You don't have to put ticks. You could put circles or squares. I'm going to try that.
Daniel:	What if you make sets of the numbers?
Teacher:	Have a go on the paper, but remember I should be able to look at your recording and tell straight away which number was the most popular answer.

As a natural extension of the earlier sessions this activity allowed the children to develop skills in handling data. The teacher adopts a more focused approach with direct questions to assess the understanding.

- How can we record this information so that we can easily see how many times we had 7 as an answer or how many times we had 6?
- Think about all of the possible answers that we could get. What would be the highest answer?
- What is the next one you get?
- What will that add up to?
- Have a go on the paper, but remember, I should be able to look at your recording and tell straight away which number was the most popular answer

Notice that the last instruction is once again dependent on Strategy 1, and releases the teacher for assessment purposes.

Further comments

Very little discussion ensued during the initial session. The children were able to describe the cards, but there was little other interaction. Daniel's response of 'two' to the question 'How many children can you see?' cut the conversation dead and required further teacher input. This is in contrast with the children's contributions during Session 2 in which the children interact with little input from the teacher. Throughout Session 2 the teacher **values** what the children say and encourages **positive attitudes**. The teacher's role is crucial to the success of the discussion. Jason is brought into the discussion through direct questioning. Jason's response stimulates more comments from the children and enhances the activity by providing the teacher with the opportunity to develop the children's work on number bonds in addition to seven.

Sessions 2 and 3 are more successful than Session 1 because the teacher interventions are carefully controlled and allow the children to take

the lead. The teacher's role is one of facilitator, enabling the children to enter into discussion with each other.

Through analysing this style of teaching and learning a number of advantages become apparent. The main reasons why a discussion approach to learning is recommended are:

i) to develop a positive attitude to learning by encouraging children to work together, share ideas and co-operate;

ii) to allow children to negotiate meaning from what they are doing and as such help them to develop their understanding;

iii) to improve the children's linguistic skills;

iv) to allow teachers to make an assessment of the above points.

6.3 ROLE OF THE TEACHER

In the continuing debate over how children should be taught, there is no firm evidence to demonstrate that any one teaching style is best. However, there is a growing body of research evidence which offers guidance on children's learning as being the most effective when:

- it is based on the individual needs of the child;
- it is meaningful, relevant and purposeful;
- it has the child at the centre of the learning process;
- it involves interaction with purposeful discussion.

The positive outcomes of this research are based on experiences gained over the four year period, and clear messages similar to those above have been identified. The role of the teacher as facilitator is crucial in the educational development of the child. Teachers need to:

i) clarify the purpose of learning;
ii) clearly define their role;
iii) identify action criteria that allow the effectiveness of their role to be monitored and evaluated.

A model has been developed and designed to enable teachers to focus on issues related to their role in the learning process. It is of particular benefit to teachers wishing to develop an interactive discussion based approach to teaching. The model (see Fig. 6.3.1) provides opportunity for teachers to:

i) focus on specific targets (A);
ii) address identified criteria (B);

in order to develop a plan of action that can be monitored and evaluated to improve the quality of teaching.

Fig. 6.3.2 shows this model in action. The identified need is:

> "To provide experiences that meet the needs of the individual child. These experiences need to be built on a knowledge of **how** children learn effectively".

In order to achieve this aim, careful thought needs to be given to **how** to plan steps so that action can take place.

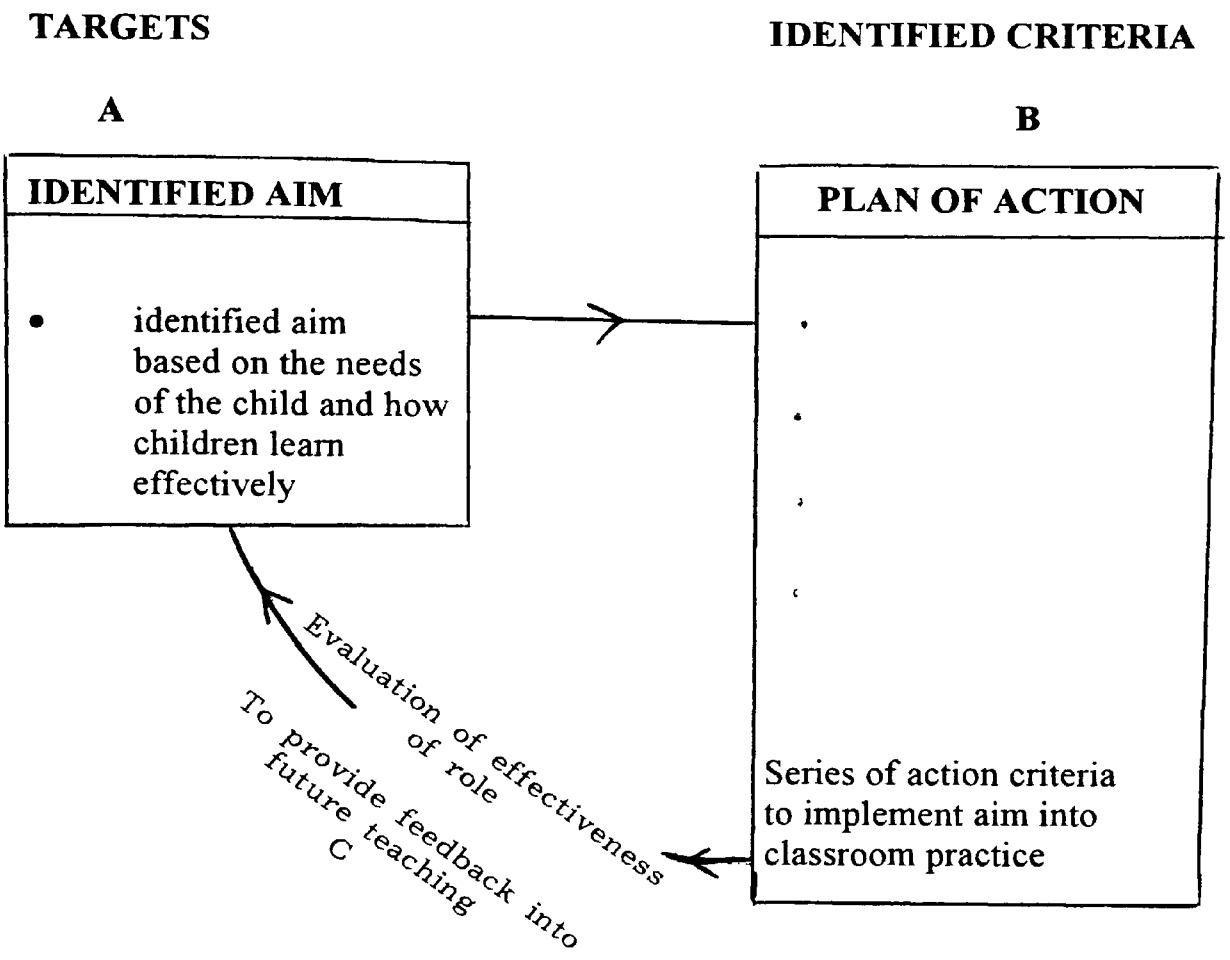


Figure 6.3.1 : A model for evaluating the role of the teacher

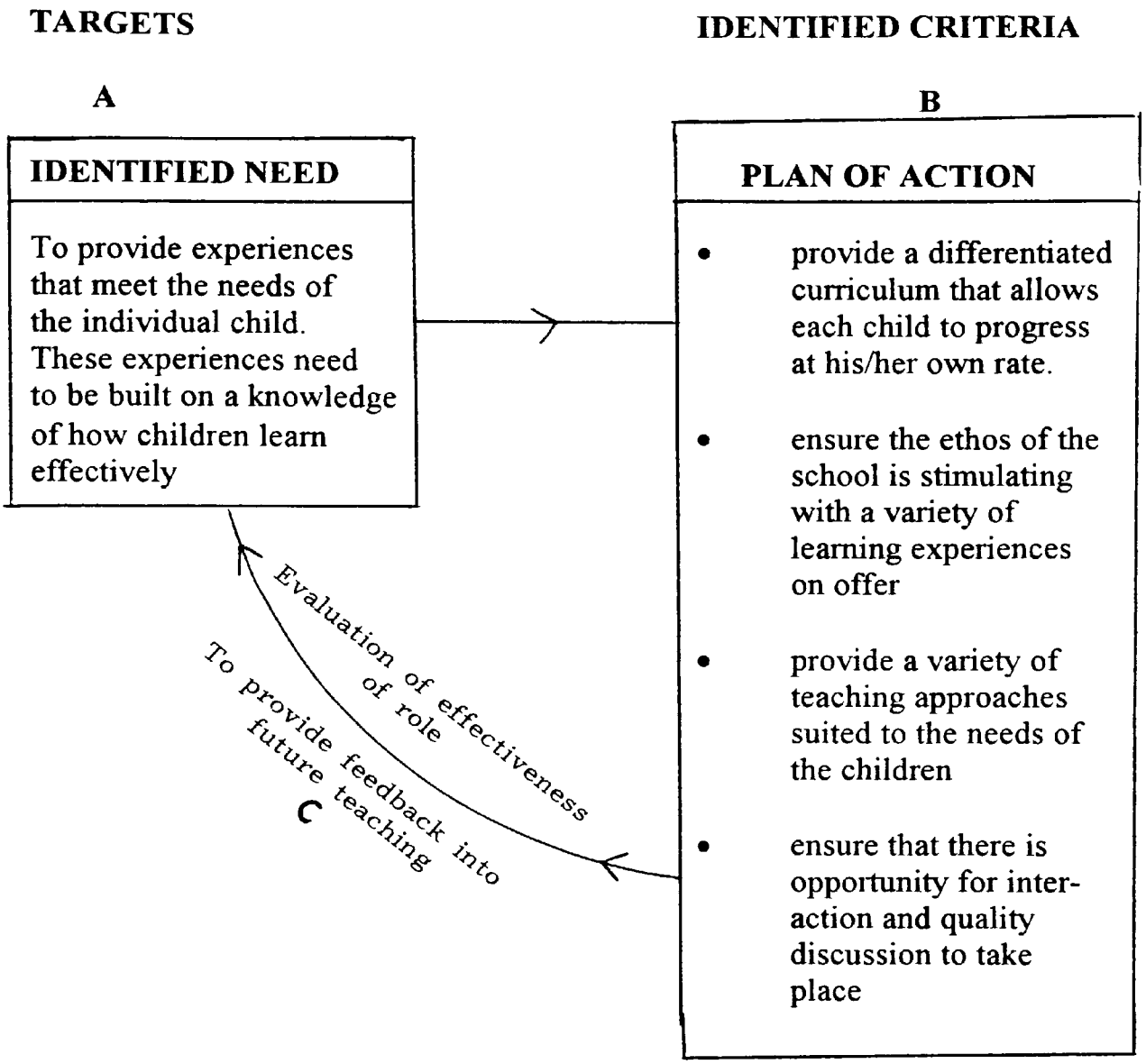


Figure 6.3.2: Evaluating the teacher's role

Teachers need to:

- provide a differentiated curriculum that allows each child to progress at his/her own rate with confidence;

- ensure the ethos of the school is stimulating with a variety of learning experiences on offer;

- provide a variety of teaching approaches suited to the needs of the children;

- ensure that there is opportunity for interaction and quality discussion to take place.

The above action points give general indicators for teachers to focus on. Each point can be broken down further into enabling targets that will allow the teacher to focus on specific issues related to the needs of the children. They can also be used as discussion points in staff meetings so that a whole school approach is developed. Aspects relating to this will be discussed in Chapter 7.

Other issues that need to be considered when debating the role of the teacher are:

- **classroom organisation** and management with specific reference to the ways in which children are grouped (spatial arrangement or arrangement requiring collaborative learning);

- **resources** and the range of suitable materials that extend and stimulate children's learning;

- **attitudes** that reflect confidence, independence and the ability to communicate effectively;

- **purposeful INSET** including a plan that encourages the professional development of staff over a period of time;

- **planning** and a cohesive policy to implementing the curriculum.

In order for effective teaching to take place, teachers need to employ a range of skills related to:

- planning;
- observing;
- recording pupils' progress.

Using such skills in classroom practice is the responsibility of the teacher and as such is a major challenge. Teachers need to acknowledge the importance of these skills in order to begin to implement them into everyday teaching.

Fig. 6.3.3 shows how, using the model discussed above, the teacher can address issues related to planning, observing and recording pupils' progress. Having broadly identified areas to be developed, a more specific breakdown of skills is necessary. These will include:

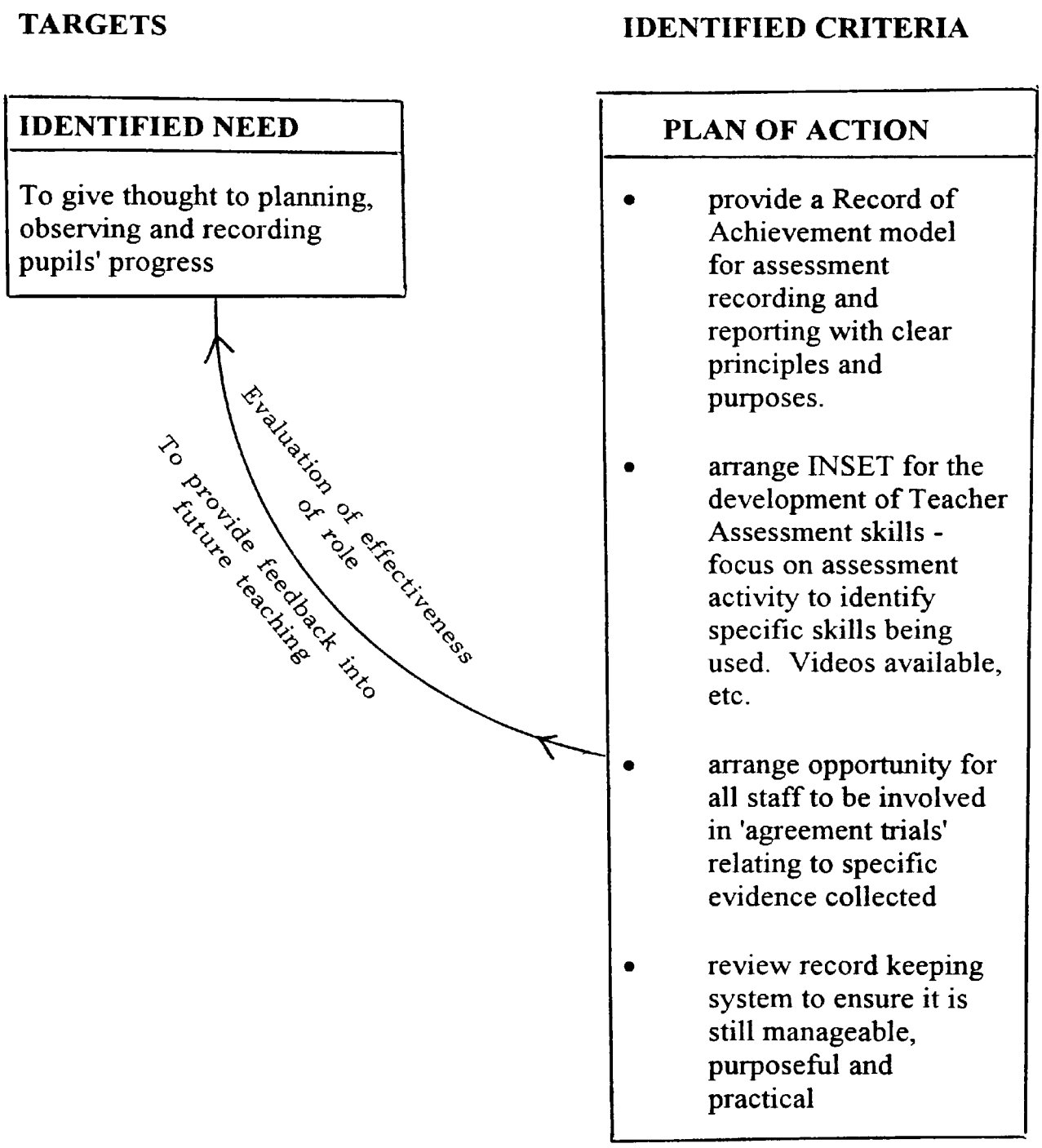


Figure 6.3.3: Action plan - planning, observing and recording pupil's progress

For planning:

- ensuring that the children understand the importance of being involved in their learning by encouraging them to participate in discussion;

- encouraging opportunities which allow the development of different types of talk, e.g. exploratory, reflective, evaluative, etc;

- focusing on effective management of classroom time so that there is opportunity for observation and interaction within a group to take place;

- supporting children in structured, effective classroom activities;

- clarifying:
  - i) the mathematics being developed (long or short term planning);
  - ii) what the children will achieve;
  - iii) the resources needed to carry out the activities;
  - iv) means of delivery;
  - v) assessment opportunities;
  - vi) recording procedures.

For observing:

- encouraging children to become independent with classroom resources and to negotiate with each other to help solve problems;

- developing strategies that enable the teacher to be released from the group to observe and record for assessment purposes;

- thinking very carefully about the type of intervention in the group and the effect that the contribution has on the children's learning (open ended questions enhance the quality of the discussion by encouraging children to think for themselves);

- concentrating initially on observing a small number of children until confidence is built up to enable work to take place with a group;

- recording observations to feed straight back into further planning;

- observing not only the understanding of concepts and acquisition of knowledge but the social aspect within the group and development of communication skills for discussion purposes.

For recording:

- noting down observations in a form which is easy to understand, e.g. journal, observation, record sheet, etc.;

- using audio visual aids if needed to help with recording of discussion in classroom;

- referring back to planning and recording:
  i) what each child has achieved;

ii) any surprises!

- using records of observations to gain more information on the children, e.g.
  i) what they know, understand and can do;
  ii) how they use language to communicate;
  iii) how they use language to achieve understanding;
  iv) how they interact socially within the group.

- using formative assessment to identify areas of strengths and weaknesses so that specific programmes of work suited to the particular needs of the child can be developed;

- keeping purposeful and manageable evidence of children's learning to support the professional judgements of the teacher;

- making summative judgements based on evidence collected for reporting purposes.

CHAPTER 7

A WHOLE-SCHOOL APPROACH TO DISCUSSION-BASED TEACHING

7.1 DEVELOPING A POLICY

Throughout this research, the author has given priority to developing guidelines which will be of help to teachers who wish to introduce a discussion-based approach into their teaching. The purpose of this chapter is to focus attention on the need for a whole school approach so that there is continuity of learning experiences and curriculum coverage. A whole school approach will also provide opportunity for monitoring and evaluating the effectiveness of its implementation in a manner similar to that described in Fig. 3.3.1 (page 57). To ensure success, relevant and purposeful in-service training needs to be arranged so that the professional development of all staff is supported and encouraged.

Porth Infants School has shown that it values discussion as an approach to teaching and learning by including it in their curriculum statement as one of the aims for mathematics (see chapter 3, page 45). The mathematics assessment document (Appendix A) supported by the discussion-based activities provide opportunity for teachers to have access to a wide range of learning experiences that can be integrated into classroom practice. To ensure that this approach is successful, schools need to review current practice and develop an assessment, recording and reporting policy which exploits the advantages of discussion.

Central to the ongoing process of change is the need to encourage professional development in individual teachers. The opportunity to review practice through a collegiate approach is the most likely way for teachers to enhance their own work practices. In-service courses organised through either school-based activities or from outside agencies are an important part of the review process. School-centred training is likely to be more successful as it will reflect the needs of the staff and the pupils. Providing and leading such INSET requires the development of a range of skills with carefully planned delivery based on the **identified** needs of the school.

The review initiated at Porth Infant's School as part of this research has resulted in major improvements in the documentation used to guide staff in implementing policy decisions affecting their teaching. An example of this is the development of the school's policy for assessment into a comprehensive document[54] which addresses the purposes and principles for assessment, recording and reporting throughout the school. The document reflects a greater understanding on the part of all staff involved and ensures more consistent and effective implementation. Throughout the development of the policy the staff were aware of the need to address the key issues related to implementing a discussion approach into practice and the invaluable opportunities provided by this approach for assessment, recording and reporting to take place. The use of talk as a vehicle for assessment was given paramount importance, and staff worked together to achieve common agreement on the teacher assessment strategies that needed to be developed within the school. These strategies were linked with discussion, observation and marking techniques. Ways of gathering evidence through samples of work were discussed and a set of agreed criteria developed and included as school policy. The results of this development process are included as Appendix B.

When schools are developing their own policy there are a number of principles which need to be borne in mind. All teaching staff need to be involved in preparing a written account of the agreements reached during the policy building process. Although a complete policy should be planned, changes should be introduced over a period of time and reviewed at appropriate intervals. Ultimately, the policy should be developed in the context of the 'School Development Plan'. In drawing up guidelines for developing the policy through the school, a critical review of existing current practice is needed. When considering the review, it would be advantageous if specific questions are addressed. These include:

- What, why, when and how do we assess, record and report?
- Upon what evidence are our assessments based?
- Who requires the records and how is the information used?
- To whom do we report?

The purposes of assessment, recording and reporting should be agreed by teachers in the school to ensure that there is common understanding. Once the purposes are clear, the principles which will support the school's policy can be identified and agreed. Decisions will need to be made about any changes that are required and particular attention should be paid to national requirements. Staff discussions will need to focus on aspects of existing practice that should be retained. The policy statement should represent the agreements made during the policy building process. The policy, which might begin with a general statement about the school's overall approach to children's learning, should include statements about who will do what. It will be necessary to consider who should be consulted and informed about the policy, e.g. Governors, Parents, LEA and other schools. At this stage it will be helpful

to produce an action plan for implementing the policy. The action plan should identify:

- What has to be done, when it must be completed, and who is responsible.
- Targets to clarify **who** has to do **what** and by **when**.
- Criteria by which success can be judged.
- Priorities for change.
- Realistic timescales for implementation.
- Cost and resource implications.
- INSET needs.
- Monitoring and evaluating procedures.

Successful implementation of the action plan can only be achieved if there is a clear management strategy. There will need to be opportunity for regular staff consultation with sustained support and encouragement to motivate and secure the commitment of all involved. Recognition of good practices will serve to improve the confidence of staff and place them in a better situation to identify problems that can be addressed. Finally, there needs to be a system for monitoring and evaluating the success of the implemented programme.

The whole process can be summarised in the following steps:

1. Gather information about assessment, recording and reporting.
2. Review existing school practice in relation to assessment, recording and reporting.
3. Identify and agree the purposes.
4. Identify and agree the principles.

5. Decide **how** current practice needs to change.
6. Draw up a written whole school policy.
7. Consult and inform those who need to know about the policy.
8. Produce an action plan to implement the policy.
9. Implement the plan.
10. Review and evaluate the effectiveness of the policy to feed back outcomes (positive and negative) into review for further refinement if necessary.

This guidance was included in the Record of Achievement Document[55] which was published by Mid Glam LEA and disseminated to all Infant, Primary and Junior Schools in the Authority during the Autumn Term 1992. The model presented in that booklet was suggested by the author as a result of experiences gained during this research. The main purpose of the booklet was to offer guidance to schools who wished to implement a recording system that was purposeful, manageable and practical. Within the document there is access to guidance on developing a whole school approach through use of an **Inset Activity Sheet**. This sheet, together with examples of its use, are included as Appendix C. It provides extra help for teachers who prefer to follow a structured approach in their staff meetings. The sheet also serves as a permanent record of the staff discussion, enabling teachers to provide a consistent approach to monitoring the effectiveness of the curriculum.

7.2 CLASSROOM MANAGEMENT AND THE ROLE OF THE TEACHER

In order to help teachers focus on changes that may be necessary to enable a discussion approach to be used in developing mathematical understanding, we a need to clarify the key issues to be addressed. These issues will include:

- classroom organisation to support interactive learning;
- planning effective mathematical situations that generate discussion;
- developing effective assessment, recording and reporting procedures to monitor the progress of each child.

To address the above issues staff will need to develop their thinking with regard to:

i) the changes needed for this new style of working to be included in everyday classroom practice;
ii) the benefits and advantages of talking and listening to one another;
iii) the role played by discussion in the development of mathematical thinking;
iv) other benefits that this style of teaching encourages (e.g. social skills, speaking and listening);
v) their role as facilitator of learning;
vi) how they can monitor and evaluate this style of working.

My experience during this research and in previous projects indicates that the first issue highlighted above, classroom organisation, is fundamental in changing styles of working. Closely linked with it is the need to develop

teachers' decision-making about individual performance during group activities. Within the school situation children may be grouped in a variety of ways to suit various organisational or learning needs. Within individual classes children will be grouped in differing combinations to suit particular circumstances. Fig. 7.2.1 illustrates how different approaches to organising children will meet the demands of classroom interaction and curriculum delivery.

If children are to realise their full potential then the composition of the group needs to be an important consideration. By providing a range of activities in a variety of contexts it is possible to enable children to perform to their full potential. Assessment in this format then enables teachers to use information gathered to evaluate, review and modify the curriculum. By emphasising an ongoing programme, teacher assessment becomes developmental rather than merely a snapshot which focuses on a single achievement at a particular moment in time.

Teacher assessment has been given a prominent place in the assessment programme underlying the National Curriculum. However, it is becoming clear that teachers may find difficulty in apportioning enough time to organise, plan and deliver such teacher assessment in every area of the curriculum. Thus there is a need for schools to plan in-service training to address the important issues of classroom management involved in satisfying the statutory requirements. Clearly, teachers will need time in the classroom to:

- observe children and record observations;
- engage in discussion with children to identify what they know, understand and can do;
- complete individual profiles and records of achievement.

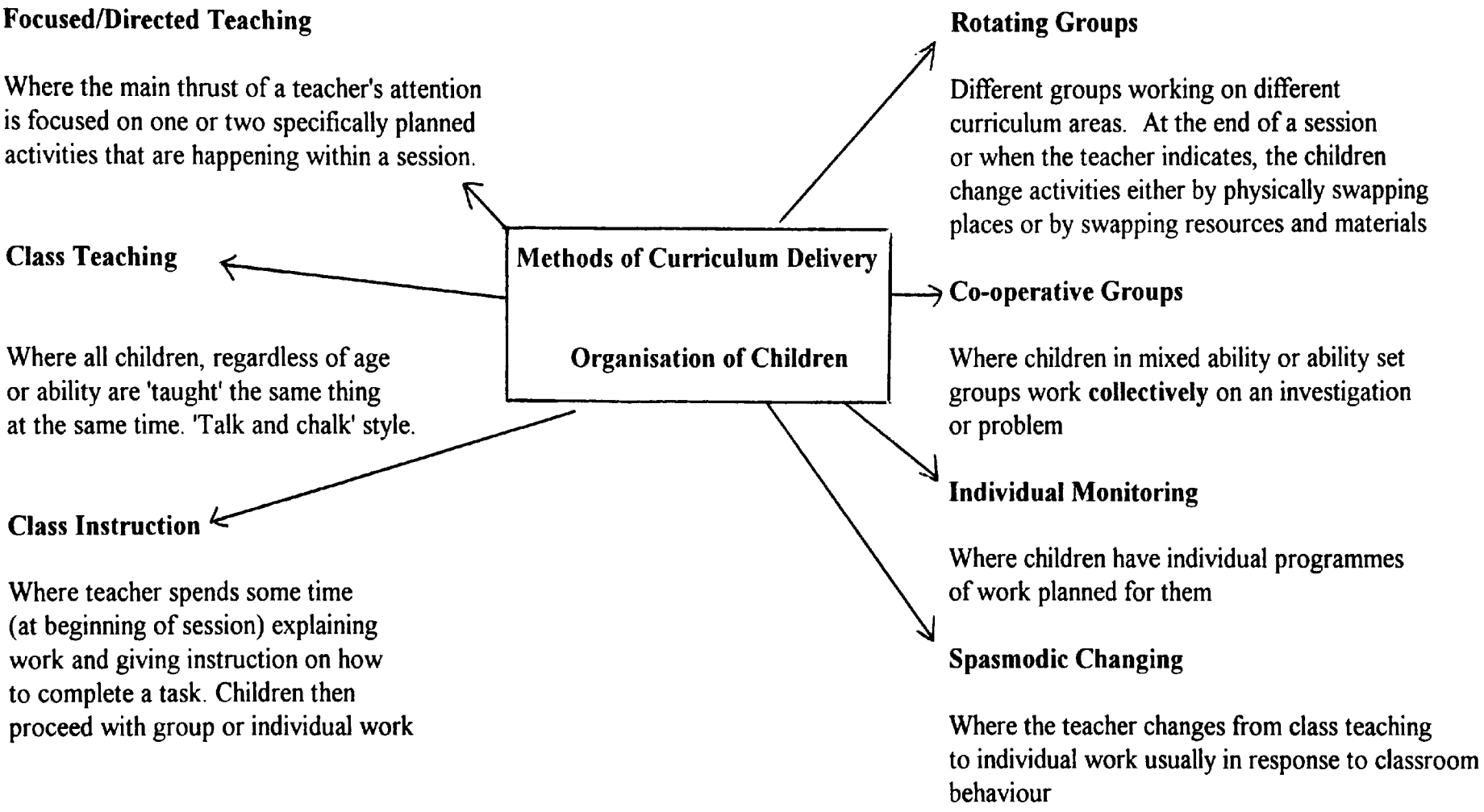


Figure 7.2.1: Organisation of groups of children

Many schools are at different stages in their development of satisfactory teaching programmes, and in vastly different situations from their neighbours. While catchment areas vary considerably from one school to the next, they all contribute to create a unique learning environment with its own strengths and weaknesses. Thus a school should tailor its INSET to integrate with its identified needs and curriculum requirements. In the end the quality of assessment rests with the individual and the professional development and expertise that the individual possesses. It is this professional development that schools can focus on to improve the teaching and learning within their school.

The activities described in this research allow teachers to focus on necessary skills and issues and by so doing encourages them to develop their expertise in these matters. Such skills include the ability to:

- become involved in the learning of children;
- reflect on classroom practice;
- share experiences with colleagues and other staff members;
- develop teacher assessment as an integral part of planning;
- monitor, record and evaluate children's progress.

Good primary practice requires time to be set aside for careful school planning in order to establish long term goals, review schemes of work and consider any organisational implications. In order to achieve effective implementation and delivery of the whole curriculum, schools need to focus their attention on long, medium and short-term planning.

Long term planning involves making modifications to the existing curriculum where necessary to ensure that each child covers the appropriate programmes of study. It involves developing a whole school approach to

planning, monitoring and evaluating the curriculum over a period of time and developing a policy for assessment, recording and reporting.

Medium term planning involves the consideration of knowledge skills, concepts and attitudes which need to be fostered and the review of work previously covered by the children in order to ensure progression. Teachers need to focus attention on programmes of study to ensure a balance in all areas of the curriculum over a period of time which may be a week, fortnight, month, half term or a term.

Short term planning involves writing out daily and weekly plans with priorities to include:

a) specific activities for class/group and individual pupils;
b) identification of teacher input and expected learning outcomes;
c) balance throughout the curriculum;
d) resources required;
e) delivery and presentation;
f) assessment opportunities;
g) records of children's work.

In order to find time for this teachers will need to look closely at their classroom organisation and find the best ways to use their time effectively. Planning is an essential ingredient in this process, and teachers will benefit from organising their time and the children's time to ensure that delivery of the whole curriculum is being met. Teachers must consider how the organisation of their classrooms will support children in worthwhile learning experiences. A well organised classroom will not only help children to become independent

learners, but will also provide the teacher with more time for discussion and observation to take place.

To enable teachers to review their current classroom provision, School Management Sheets 1 and 2 (Figs. 7.2.2 and 7.2.3) have been designed to allow staff to identify specific starting points and respond to any necessary needs. Sheet 1 provides staff with a structured opportunity to identify their current position, plan any changes or additions they would like to make to existing practice, and identify implications for staff development and training. Sheet 2 is concerned with implementing the changes into classroom practice. Having identified the need in Sheet 1, staff need to plan the development for change, consider how to implement plans into action, and follow up with an evaluation of the development through identified performance indicators. The information gathered through the process should feed back into the plan for refinement if necessary.

When the sheets were used at Porth Infants School a number of advantages were identified. These included the raising of enthusiasm amongst staff due to the fact that they had been involved in the early planning and decision making process. The opportunity to use the same sheets to focus on any area of the curriculum was reassuring and it was found that the sheets could also be used to help the future planning of programmes of study related to the professional development of the staff. Performance criteria agreed at the staff meeting provided access to monitoring and evaluating the effectiveness of the review.

The sheets were also used to focus on reviewing the organisation of the school as an aid to supporting a discussion based approach to teaching. The completed forms are displayed in Appendix D. Sheet 2 shows how the staff

Sheet 1

SCHOOL MANAGEMENT	CONDUCTING A REVIEW	
IDENTIFIED STARTING POINT	CHANGES/DIFFERENCES/ADDITIONS	STAFF DEVELOPMENT
→	→	→
→	→	→

Fig. 7.2.2 : School Management Sheet 1

SCHOOL MANAGEMENT	CONDUCTING A REVIEW / STAFF DEVELOPMENT SHEET	
AIM/TARGET BASED ON IDENTIFIED NEED		
PLAN OF DEVELOPMENT OF CHANGE	IMPLEMENTATION AND GROWTH	ASSESSMENT AND EVALUATION

Fig. 7.2.3 : School Management Sheet 2

addressed the difficult aspect of resourcing the classrooms to support discussion and interactive learning. The plan of development for change offers a series of sessions for action to take place over a six-week period. At the end of the period the design criteria were used to assess and evaluate the effectiveness of the process. Teachers focused on the children's ability to make choices with regard to the appropriate resources to be used for the task in hand. They concentrated on the child's ability to persevere with a task and used the children's own comments to evaluate the success of the process. The resulting information provided valuable feedback for use in developing a whole school policy on Resourcing at the next staff meeting.

These sheets now need to be trialled in the field so that a full evaluation of their potential can be made. Further research could address this issue and possibly relate the findings through a model similar to that described in Chapter 6 (Fig. 6.3.1). This model would form the basis for an INSET session. The process of discussing and agreeing upon the action points would provide teachers with a structured plan to develop. The completed model would act as evidence in the form of a written account of the steps needed for action to take place over a period of time. Access is now available for monitoring and evaluating the process as a whole.

CONCLUSIONS

This research highlights the important principles that underpin the processes involved in a discussion-based approach to teaching mathematics. A profile has been built up of the various elements that contribute towards this approach and the ways in which these elements are linked together.

A major outcome of this research has been the development of a series of effective mathematical activities that provide opportunity for discussion and active learning across Key Stage 1. The activities have been cross-referenced into the scheme of work for Mathematics at Porth Infants School. They provide a package of differentiated support material for the teaching of mathematics through a discussion based approach. The flexible nature of the package produced allows for additional material to be included as it is developed. It is intended to produce a bank of activities that will eventually cover the whole range of all areas of mathematics so that staff will have access to choosing appropriate material to support their teaching needs.

During the development of the activities opportunity was seized to monitor and evaluate the progress of each child taking part. A major outcome of this process has been the development of a series of record-keeping sheets that enable teachers to focus attention on the difficult task of gathering evidence to support teacher assessment. The information obtained when trialling the sheets was analysed and used to plan future activities and as such served to improve the quality of teaching provided. By monitoring the children in this manner a record-keeping system was developed which gradually built up a picture of the child's development in mathematics, identifying progress and highlighting achievement. The recording sheets have provided opportunity for focused assessment to take place. They provide evidence for future monitoring

and evaluation so that information gathered can be used to improve and modify the curriculum.

When involved in using the activities the children were encouraged to develop their mathematical thinking and an awareness of their own intuitive methods of solving problem. Individual methods were subject to group checking, but if a method did not work, or if a mistake was made, then this was not considered vital as the emphasis was on exploring ideas and finding out how to approach a problem. Through the discussion approach children became confident and were prepared to express opinions. Encouraged by their peer group they invariably benefited from any help and guidance on offer. The focus on discussion and the use of 'talk' as a vehicle for teacher assessment was given paramount importance and this issue was developed and exploited throughout the research.

The experience gained from this research has indicated that the quality of 'talk' offered by a child is dependent on a number of factors. Apart from the social context in which the activity takes place, evidence has shown that there is a significant need for children to be able to interact with each other and with their teacher. The adult in the group became a role model for the children to follow, and this produced some interesting results with children imitating the action of the teacher. By valuing what the children said the importance of their contribution was recognised, and this in turn encouraged them to become more confident and to value the opinions of others. The use of 'open ended' questions promoted an enquiry-based approach to learning. This research has shown that children taught in this way use a similar approach amongst themselves, resulting in an ability to ask questions and respond appropriately. These are skills that children need to acquire not only for using and applying mathematics, but also as an essential skill for use across the whole curriculum.

During this research it became apparent that the role of the teacher is crucial in the educational development of the child. Regardless of activity it is the teacher's approach which encourages the pupils to contribute to the discussion and which governs the quality of their responses. Evidence has been accumulated to support the notion that a particular intervention will encourage children to develop their thinking while learning from the experience of their peer group. The teacher's role becomes one of facilitator, enabling children to enter into discussion with each other, and to share and compare their ideas. The pupil's role becomes active as they work together, share ideas and negotiate meaning from what they are doing.

The model (see Fig. 6.3.1) developed to enable teachers to focus on issues related to their role in the learning process has provided numerous benefits when implemented into classroom practice. Through use of the model opportunity has been provided for focused planning and to develop an action plan that can be monitored and evaluated over a period of time.

The strategies described in Chapter 6 have been developed to improve the quality of teaching taking place. They have been structured so that they can be incorporated as an integral part of classroom teaching. Wherever possible they seek to maximise teachers' time with pupils. Evidence gathered from trialling the strategies has shown that effective organisation is essential to release the teacher from the task of managing the rest of the class. The strategies provide a means of achieving a successful classroom management policy through school based action and research.

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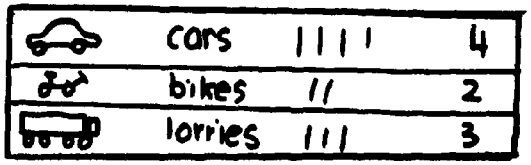
APPENDIX A

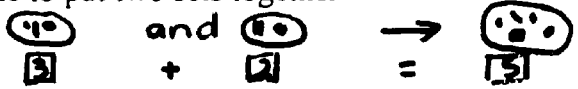
NUMBER ASSESSMENT DOCUMENT

RED STAGE CARDINAL NUMBERS 1 to 5		YELLOW STAGE ORDINAL NUMBERS 1 to 5	
1. a) b)	Child says number name as he moves objects along Child is able to show 'How Manyness' of a set. (The idea of these activities is that each child recognises that he is using a number to describe the whole set.	1.	Child is able to put a set of clothes on bottom clothes line exactly the same as above.
2.	Child is able to match symbol to set (1 to 5).	2.	Child is able to reverse order.... (This will assess child's concept of order (see Nuffield N4 page 46)
3.	Child is able to match number word to set.	3.	Child is able to move sets so that they are in order - aim should progress towards ordering 0 to 5 (use card for checking).
4.	Child is able to understand that each set has a number property and it is the number of members in the empty set which is called zero	4.	Child should be able to compare cardinality of sets, i.e. number of members of one set with number of members of another set. Expressions More than/Less than/Equivalent are used.
5.	Child is able to understand and conserve number no matter how members are arranged.	5.	Child is able to make a stroke for each member of a set, e.g. 
6.	Child develops ideas of invariance of number in a set regardless of arrangement.	6.	Child is able to tally, e.g. 
7.	Child is able to make a fair **estimate** of small number of objects (up to 5).		

See *Nuffield Mathematics Teachers Handbook I* for vocabulary/ equipment and apparatus/activities/games .... pages 27 to 41

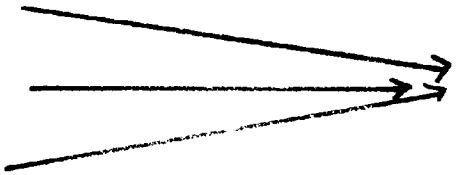
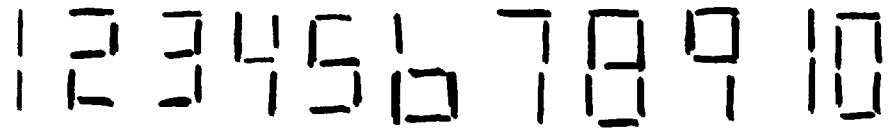
See *Nuffield Maths Handbook I*, pages 42 to 55

BLUE STAGE

	CONCEPT OF ADDITION 0 to 5 CONCEPT OF SUBTRACTION 0 to 5
1.	Using bead bags (or similar apparatus) the child is able to rearrange beads within bag and say number pattern, e.g. "I've put 2 beads in this corner and 2 beads in this corner" etc.
2.	Using 'Duck pond' activities, child is able to find many different ways of partitioning into two sets.
3.	Child is able to make the number story of 5. 5 is the same as 4 and 1, 3 and 2 ... etc.
4.	Child is able to **copy, continue and devise** repeating patterns represented by objects/apparatus or single digit numbers, e.g. 2,1,2,1,2,1,2,1,....
5.	Child is able to put two sets together 
6.	Child is able to use structured apparatus joining two sets.
7.	Child is able to record by mapping without using apparatus.
8.	Through practical experiences a child shows ability to map two sets to determine the difference between them.
9.	Child is able to count forwards and backwards on a **number line**.
10.	Child **understands** 'Taking Away' using apparatus and pictures with numbers 0 to 5.
11.	Child is able to add and subtract to 5 without the help of apparatus.

See *Nuffield Mathematics Teachers' Handbook I, pages 56 to 58*

GREEN STAGE

	Introduction of CARDINAL/ORDINAL NUMBERS 6 to 10
1. 2. 3.	Repeat as in red section  Using numbers 6 to 10
4.	Child is able to order 0 to 10
5.	Child is able to make a reasonable **estimate** of sets of objects to 10.
6.	Child is able to recognise numerals on calculator display and use sticks to make the numbers practically. At this stage the aim is to make the child familiar with the calculator and its use.
	

ORANGE STAGE CONCEPT OF ADDITION 6 TO 10		PURPLE STAGE CONCEPT OF SUBTRACTION 6 TO 10
Repeat stages in Section 3 using numbers 6 to 10 for first three stages. 1. 2. number values 6 to 10 3.	1.	By mapping members of 2 sets child is able to draw a ring around the difference.
4. for stages 4, 5, 6 use number 5. values 0 to 10 including use of 6. number line or wall	2.	Child is able to count backwards on a number line from 10 to 0.
7. Child should be able to construct 'Block Graphs' of group work - handling numbers to the value of 10. Child should be able to read and interpret results.	3.	Child understands 'Taking Away' using picture problems.
8. Child should be able to represent result of classifying using two different criteria, e.g. Carroll Diagram (see Bulmershe Cards).	4.	Child is able to subtract using structured apparatus.
9. Child should be able to make reasonable estimate of addition of sets of objects to 10.	5.	Child is able to subtract using mapping.
	6.	Child understands the following examples and is able to write number stories about them (Explaining and Using Patterns, see p.5) $7 + 3 = 10$ $7 - 3 = 4$ $3 + 7 = 10$ $7 > 3$ by 4 $3 < 7$ by 4 also $7 + \square = 10$ $\square + 3 = 10$ AT3 2a/2b $7 - \square = 4$ etc. AT2 2(a)
	7.	Child is able to understand simple operations with use of 'Function Machine' Input → Output 3 → 5 7 → 9
	8.	Child is able to investigate number patterns with calculator. AT3
	9.	Child is able to make reasonable estimate of number to 10 in addition and subtraction activities.

SILVER STAGE TWO DIGIT NUMBERS		GOLD STAGE INTRODUCTION TO MULTIPLICATION/DIVISION	
1.	Child is able to group in 5's, 4's etc. using, e.g. boats, nets, fish	1.	Child is able to recognise and count equivalent sets.
2.	Child is able to group in 10's, e.g. 'The Old Woman has room in her shoe for 10 children, 17 come to stay so 7 have to stay outside'	2.	Having sorted sets the child is able to answer questions, e.g. How many sets altogether? by counting in 2's, 3's, 4's, and 5's 1 set of 2 1; 2 sets of 2 (2+2) 4
3.	Child is able to say that: 22 is the same as 2 tens and 2 units and .. use number for pattern work, e.g. 4 + 10 = 14; 14 + 10 = 24 etc.	3.	Child shows understanding of the 'Commutative Law' 3 rows of 2.....2 rows of 3.
4.	Child is able to add to twenty using apparatus including number line.	4.	Child is able to produce (know, understand and use) table facts to 30 in written form and mentally.
5.	Child is able to subtract to twenty using apparatus including number line.	5.	Through practical experiences child understand the **sharing aspect of division.**
6.	Child is able to make reasonable estimates of numbers to twenty using addition and substraction activities.	6.	Child understands that division is the **inverse of multiplication by completing multiplication squares and:** **12 = 4 x 3 and 3 x 4 = 12** **12 ÷ 4 = 3 and 12 ÷ 3 = 4 etc**
7.	Child is able to perform 4 and 5 without apparatus and able to give correct response to **'mental'** calculations.	7.	Child is able to **read, write and order numbers to 1000.**
8.	Child is able to use and understand place value in the context of **Tens and Units** covering addition and subtraction **facts.**	8.	Child is able to interpret graphs (pictograms) where the symbol represents a group of units.
9.	Child is able to deal with **inputs and outputs** from simple function machines.	9.	Child is able to investigate number with the use of a calculator, e.g. 'You can only use each key once. What is the largest number you can make adding two digit numbers?
10.	Child is able to read and interpret Block Graphs and Carroll Diagrams - Handling Data (to 20).		

See *Nuffield Handbook 2* (pp.13 to 48)

APPENDIX B

PRINCIPLES FOR ASSESSMENT, RECORDING AND REPORTING

PORTH INFANTS SCHOOL

PRINCIPLES OF ASSESSMENT

Assessment should:-

* be concerned with the whole child;

* enhance the quality of teaching and pupil learning;

* be carried out unobtrusively so that children are not aware that they are being assessed;

* give the child confidence, through a feeling of success;

* be supported by good quality evidence;

* be a continuous process that helps teachers plan their teaching effectively;

* be based on clear objectives;

* be made on the basis of work done in various contexts;

* be a normal part of the day-to-day work of teachers;

* be communicated to all who need to know;

* be manageable and time effective;

PORTH INFANTS SCHOOL

Principles for Recording Childrens Progress

"Recording information about pupils' achievement and progress, although important, is only part of the assessment process and not an end in itself."

A Guide to Teacher Assessment. KS1 and 2
SEAC. 1989

The records that teachers keep should serve a variety of purposes:

*show coverage of the curriculum to enable the planning of future learning objectives which allow for continuity and progression

*summarise individual pupil achievement relating to the statements of attainment to inform about and report on pupil progress

*provide the basis for the summary Record of Achievement

*be meaningful to pupils and others who have access to them

*be manageable and time effective.

Where a child is taught by more than one teacher, information on pupil achievement needs to be a shared process. By sharing the outcomes of their formative and diagnostic assessments, teachers can identify common areas of achievement, progress or difficulty. This will enable them to identify future learning targets more easily.
The teacher receiving a child at the beginning of the school year should receive information relating to previous coverage and achievement.

The school's assessment procedures will be reviewed on a regular basis. The records that teachers have made will be used to carry out evaluative assessments of the learning provision.

PORTH INFANTS SCHOOL

PRINCIPLES OF GOOD REPORTING

Reports should:

* set out **what** pupils have learned, not just what they have been taught;

* highlight positive achievement and progress made;

* summarise the pupil's performance since the last report;

* be written with the reader in mind- succinctly and without unfamiliar jargon;

* identify weaknesses and suggest positive future action:

* be seen in the context of the 'Record of Achievement' so that achievement can be reported as well as attainment;

* be meaningful and tailored to the circumstances of the individual child.

Legal Requirements

There is a statutory obligation on schools to report to parents. The Education Reform Act states:-

> "Reporting about individual children should be confidential to their parents, teachers and where necessary the LEA and Governing Body. It should normally be in terms of the level reached in each assessment profile component".

The Secretary of State for Education also stated that at 7, 11, 14 and 16 there should be a report to show the pupil's statutory assessment results in National Curriculum subjects.

PORTH INFANTS SCHOOL

PRINCIPLES FOR RECORDS OF ACHIEVEMENT

The key elements of a framework for RoA in primary school should:-

* be based on the principles for assessing, recording and reporting pupil's achievements;

* be sufficiently flexible to provide schools with the opportunity of developing and implementing their own ways of recording achievements, reflecting particular needs and providing the necessary sense of ownership;

* meet the requirements of National Curriculum and support the development of the whole curriculum;

* be part of a whole school curriculum policy;

* involve pupils and teachers in regular discussion to review progress, attainment, achievement and experience and plan the next steps;

* contribute to pupils personal development and progress by improving their motivation, providing encouragement and increasing their awareness of strengths and weaknesses .

* recognise and give credit for what pupils have attained, achieved and experienced not just in terms of National Curriculum assessments but in other ways as well;

* support the progress of pupils through schools and enable summary documents to be readily produced as required. The record should form the basis for the annual reports to parents and transfer documents, to communicate a rounded picture of the whole child to parents, teachers and others identified by Regulations

APPENDIX C

INSET DISCUSSION RECORD SHEETS

These sheets allow staff to identify the aims of the session and provide relevant information and guidance to enable issues and policy to be agreed. The discussion points provide a structure that enables staff to engage in purposeful dialogue

PORTH INFANTS SCHOOL
SCHOOL - BASED INSET

DISCUSSION ACTIVITIES FOR STAFF MEETINGS.

AIMS

INFORMATION

INSET ACTIVITIES

SCHOOL - BASED INSET

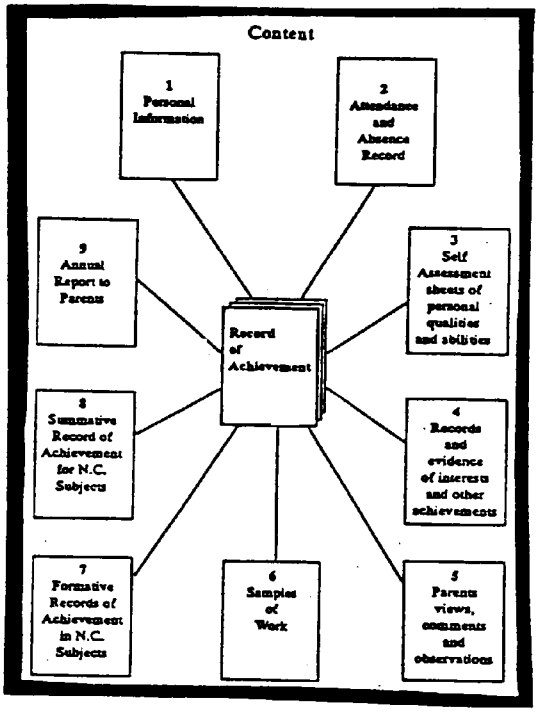
DISCUSSION ACTIVITIES FOR STAFF MEETINGS.

AIMS

(i) To consider the types of information that you want to keep in a Records of Achievement for your school.

INFORMATION

The recommended content of the RoA for Mid Glamorgan is based on the experiences gained from the pilot schools and includes



INSET ACTIVITIES

* As a staff, make a list of the aims you share for the children you teach. Identify any aims for which achievements would not be recorded by Statements of Attainment. (SoAs)

* If you value these aims, are you able to provide evidence to support their importance to parents, governors and other interested parties?

* What are the implications of your conclusions for the records you want to keep in your school?

* Design a flow diagram (as above) to show what you would like to be included in the RoA for your school.

SCHOOL - BASED INSET

DISCUSSION ACTIVITIES FOR STAFF MEETINGS.

AIMS (i) To consider the type and range of formal school record sheets within your school.

INFORMATION

Many schools maintain a variety of formal records. These will probably include a summative sheet for each individual child which is passed from class to class at the end of each year. These sheets usually refer to the core curriculum. Routine tests and SAT results, where appropriate, may also be included.

INSET ACTIVITIES

* Review the records you currently keep in school and consider:

(i) How many of the official ones are (a)summative (b)formative?

(ii) Are there any gaps in the record keeping system?

(iii) Is there any duplication?

(iv) Is the information that is passed on used formatively by the receiving teacher?

(v) Are the records manageable and is the information easily accessible?

(vi) Do records meet statutory requirements for passing on to the next phase of pupil's education?

SCHOOL - BASED INSET

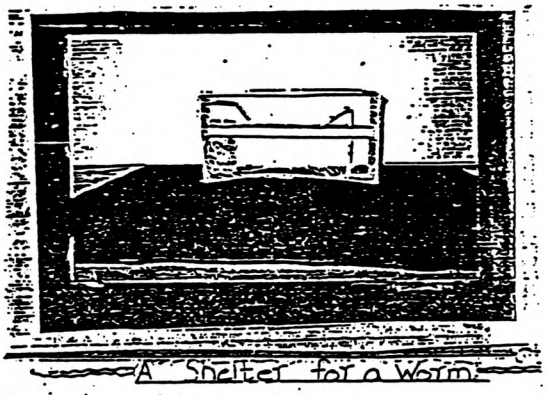
DISCUSSION ACTIVITIES FOR STAFF MEETINGS.

AIMS

To agree a consistent approach for annotating children's work.

INFORMATION

date?
criteria for selection?
independence?
curriculum area?
assessment level?



A Shelter for a Worm.

I am a little unpleased with my shelter for a Worm I want to change my Shelter by doing borders around and Painting it. Other wise I am quite Pleased with it and I think the worms will like it very much.

INSET ACTIVITIES

* Discuss the information that you would find useful to accompany samples of children's work.

* What is the optimum information that you feel should be included? Consider the benefits and/or disadvantages in using such things as adhesive labels, duplicated proformas, date stamps and so on.

* Agree a format that will meet your needs and trial it for a half term.

* Plan a review before including in the final policy.

APPENDIX D

SCHOOL MANAGEMENT TO SUPPORT DISCUSSION-BASED TEACHING

CLASSROOM ORGANISATION **Sheet 1**

SCHOOL MANAGEMENT	CONDUCTING A REVIEW	
IDENTIFIED STARTING POINT	CHANGES/DIFFERENCES/ADDITIONS	STAFF DEVELOPMENT
1. Does the organisation of the school support a discussion based approach to teaching and learning? →	Classrooms are organised to support groups working at different curriculum areas. Need to focus on: →	i) Need to plan and develop school based INSET →
2. Is there opportunity for i) interaction ii) group co-operation iii) development of discussion skills iv) assessment?	i) recording group work and keeping record of the 'ephemeral' nature of the discussions; ii) the planning and structure of the groups so that work is carefully monitored and regularly evaluated; iii) ensuring **time** is allowed to enable the teacher to use assessment skills.	Suggest the need to involve all staff - each teacher to focus on an activity in mathematics highlighting assessment opportunities and trying different ways of recording - material to be discussed at staff meeting. ii) Need to include visits to schools to see other classroom organisations.
3. Does the organisation of the classroom encourage children to work independently? →	Each class to carry out a stock inventory to find out exactly what is available in the mathematics area. All resources should be clearly labelled and easily accessible to children. There should be differentiated equipment in areas offering opportunity for children to: i) work practically; ii) investigate; iii) discuss; v) record. →	Discuss possibility of: i) setting up a common store area of resources not often used in the classroom; ii) improving the mathematics area by colour coding equipment; Discuss in staff meeting the evaluation of trialling the use of resources in the classroom Continued

SCHOOL MANAGEMENT	CONDUCTING A REVIEW	
IDENTIFIED STARTING POINT	CHANGES/DIFFERENCES/ADDITIONS	STAFF DEVELOPMENT
4. Time Management →	Already in place - flexible time- → tables for planning teacher and children's time.	Staff to discuss prioritising actions →
• Organisation - crucial if we are to manage time effectively.		1. essential things that need to be done 2. important things 3. less important
Need to look at effective ways of covering the whole curriculum	**Need to:** i) find ways of improving the **quality** → teaching time in classroom. (a) time for observation, (b) time for recording.	Careful planning with assessment opportunities incorporated
• cross curricular/thematic • planning etc.	ii) identify 'timescales' so that better use → of time is employed;	As staff identify time wasters and possible actions to eliminate problems.
	iii) possible use of parents! →	Using other responsible adults to help wherever possible - **training** provided.
5. Continuity throughout the school: →	At staff meetings ensuring all staff → involved in early decision making so that policies are developed and good communication encouraged throughout.	Encouraging a collegiate approach → to policy making!
By involving other/all staff members in team work, sharing information and discussing issues.	Ensuring mathematics areas are suitable resourced, e.g. listening corners, opportunity to use practical equipment, opportunity to talk and discuss.	Staff to be involved in monitoring and evaluating effectiveness of discussion activities.
Setting manageable goals that are achievable.		Also assessing and evaluating the records passed on from one class to the next. This is particularly useful.
Consistent method of assessing recording and reporting throughout school.	Develop Record of Achievement model through school (see ROA review).	

CLASSROOM ORGANISATION **Sheet 2**

SCHOOL MANAGEMENT	CONDUCTING A REVIEW/STAFF DEVELOPMENT SHEET	
AIM/TARGET BASED ON IDENTIFIED NEED: Organisation - Focus on resourcing areas to support independent learning		
PLAN OF DEVELOPMENT OF CHANGE	IMPLEMENTATION AND GROWTH	ASSESSMENT AND EVALUATION
Resources Time: 6 week development 1st Session: Initial planning stage (staff discussion) to identify and clarify: i) **How** children learn effectively ii) **Look** at **needs** of children iii) **Plan** organisation to support needs. 2nd Session: To identify needs for development - specific areas to be planned. 3rd and 4th Sessions: Trialling development into classroom practice. 5th & 6th Sessions: Evaluating - amend - include into policy for school. Continue monitoring effectiveness of changes.	• Audit resources in classrooms • Identify needs/gaps to be developed NB: Resources need to be easily accessible to all children. Look at 'coding' to differentiate apparatus and labelling so that children know where to get the appropriate resource. • Involve children in organising resources so that they can make decisions themselves. • Organise mathematics area so that children have opportunity to work practically and record independently. • Involve children in trialling resource area - possibly to the extent of evaluating their own responses at end of trial period. • Report back to rest of staff and evaluate the development.	• Trial use of resources over a period of time, approx. 2 weeks. • Design performance criteria sheet to assess and evaluate, e.g. i) Does each child need to ask where particular resource is? How often? ii) Are the resources appropriate for the activity being developed? iii) Do the children persevere at an activity? **Use** of resources needs to be carefully monitored involving children themselves. Develop whole school policy on Resourcing - link to classroom management/organisation.